A 57810 3

LETTERS AND RECOLLECTIONS OF ALEXANDER AGASSIZ

A. Agassiz

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

1837
ARTES VERITAS SCIENTIA
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
E PLURIBUS UNUM
TUEBOR
SI QUAERIS PENINSULAM AMOENAM CIRCUMSPICE

THE GIFT OF
Mr. G. R. Agassiz.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

SCIENCE
LIBRARY
QH
31
.A26
A3

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

LETTERS AND RECOLLECTIONS

OF

ALEXANDER AGASSIZ

Digitized by Google

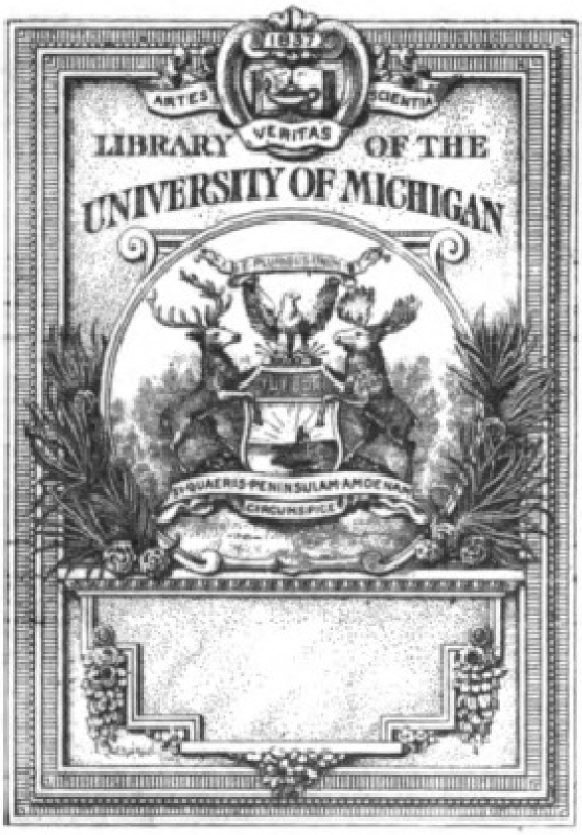
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN



THE GIFT OF
Mr. G. R. Agassiz.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

SCIENCE LIBRARY
QH
31
.A20
A3

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

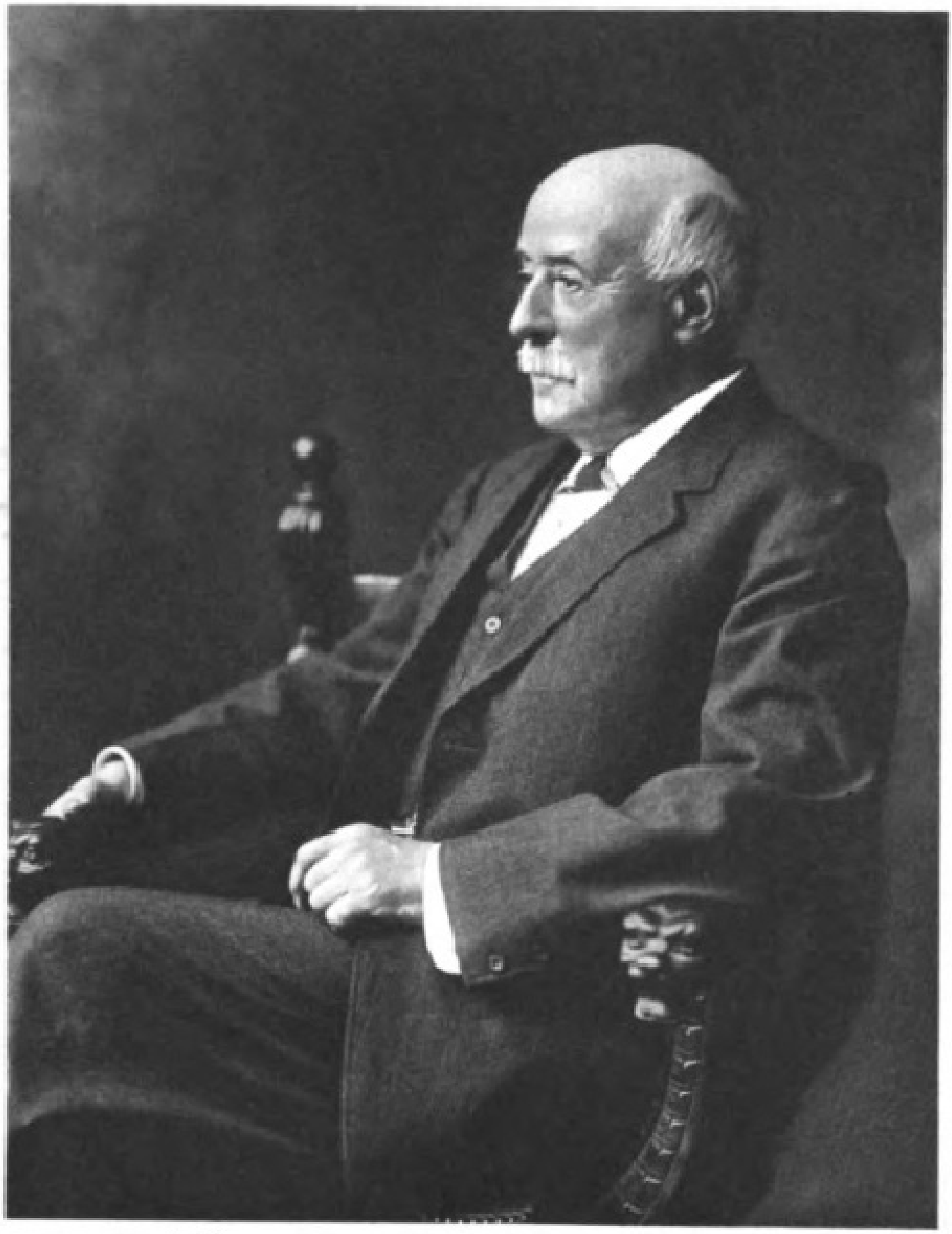
Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

LETTERS AND RECOLLECTIONS
OF
ALEXANDER AGASSIZ

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN



U of M A. Agassiz

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN



Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

LETTERS AND RECOLLECTIONS

OF

ALEXANDER AGASSIZ

WITH

A SKETCH OF HIS LIFE AND WORK

EDITED BY

G. R. AGASSIZ

WITH PORTRAITS AND OTHER
ILLUSTRATIONS

BOSTON AND NEW YORK
HOUGHTON MIFFLIN COMPANY
The Riverside Press Cambridge
1913

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

COPYRIGHT, 1913, BY GEORGE R. AGASSIZ

ALL RIGHTS RESERVED

Published October 1913

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

PREFACE

ANY one who attempts to present a faithful impression of Alexander Agassiz's life is confronted with unusual difficulties, for his versatile and restless energy covered a very extraordinarily wide field, and his personality was so large that we are hampered in our view of him by our own limitations. The morphologist considers his earlier work the most important; the geologist, that his reputation rests chiefly on his extensive investigations of coral reefs; the zoölogist remembers his vast collections of marine life gathered in a dozen extended voyages widely scattered over the surface of the globe; and to still others he appears as the creator of a vast museum and one of the greatest benefactors of the oldest university in America; while those who delve among ancient civilizations and primitive races might well be surprised at the extent of his poaching in their preserves, a mere *détour* in his many wanderings in the pursuit of science or search of health. In the world of affairs he was known as an extremely capable and successful mining man, who was said to employ his leisure moments in some sort of scientific study.

When I first began to collect material for a life of my father, I hoped that it would be possible to tell it in his own words. But grave objections to such a plan soon appeared; one of the foremost being the mysterious disappearance of most of his later correspondence with his stepmother. It is, moreover, a much more dif-

257786

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

ficult matter to make a characteristic collection of letters now than it was in past generations. *D'autres temps, d'autres mœurs;* to-day we no longer keep trunks full of old letters stored in our attics, nor do we write the leisurely and carefully penned epistles of our forefathers, while the roomy lofts that harbored them have vanished.

After it became apparent that it would be necessary to cast this book in its present form, I would gladly have handed the material to a more experienced biographer. Since no suitable person was available, it has fallen to me to complete the work, for lack of a fitting Boswell.

I wish to take this opportunity of most cordially thanking the many individuals who have kindly allowed me to examine my father's letters and have assisted in numerous other ways. I trust that they will consider their number a sufficient excuse for not mentioning them personally.

Most especially do I wish to express my warm appreciation for the help of the following persons: first and foremost, Mr. Samuel Henshaw, the present Director of the so-called "Agassiz Museum," who has given no end of invaluable assistance; my wife, whose sympathy and help have been no small factors in finishing this book; my aunt, Mrs. H. L. Higginson, who has furnished much of the material for the earlier pages; Miss Elizabeth H. Clark, my father's secretary for nearly thirty years; Sir John Murray; Dr. A. G. Mayer; Dr. H. B. Bigelow; Professor H. L. Clark; and the present Mr. Q. A. Shaw.

My warmest thanks are also due to Professor Barrett Wendell, who has kindly read the manuscript,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

and has suggested many final touches. I likewise beg to acknowledge my indebtedness to Mr. E. T. Brewster, who has been at the pains to examine the work at two different stages, and has offered much valuable criticism.

G. R. A.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

CONTENTS

I.	Descent and Boyhood	1
II.	First Years in America	14
III.	The Museum becomes his Headquarters	28
IV.	The Calumet and Hecla Mine	53
V.	The Revision of the Echini	91
VI.	Lake Titicaca	124
VII.	The Newport Laboratory	151
VIII.	Three Cruises of the Blake	165
IX.	Mexico and India	191
X.	More Wanderings and Work	213
XI.	The First Albatross Expedition	243
XII.	Coral Reefs	269
XIII.	The Bahamas and Bermudas	288
XIV.	The Great Barrier Reef	310
XV.	The Fijis	322
XVI.	The Tropical Pacific	345
XVII.	The Maldives	380
XVIII.	Later Years	397
XIX.	Eastern Pacific Expedition	419
	Index	449

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

ILLUSTRATIONS

Alexander Agassiz (*photogravure*) . . . *Frontispiece*

Cécile Braun (*photogravure*) 4

Alexander Agassiz, at the age of 12 12

Anna Russell (*photogravure*) 28

Alexander Agassiz, about 1860 (*photogravure*) . . 44

The Cambridge House 126

In the Newport Laboratory 156

The Deck of the Blake 174

The Albatross 244

Emptying the Trawl 254

Laboratory on the Deck of the Croyden 316

Figures showing the Development of an Atoll . 338

The Sultan on board the Amra 386

Diagram of a Maldive Atoll 388

"Castle Hill," Newport 398

Elizabeth C. Agassiz 404

The University Museum 416

Easter Island Images 428

Chart 1. Atlantic Expeditions . *In front cover pocket*

Chart 2. Pacific Expeditions . . *In back cover pocket*

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

LETTERS AND RECOLLECTIONS

OF

ALEXANDER AGASSIZ

CHAPTER I

DESCENT AND BOYHOOD

Agassiz is not an uncommon name in that part of Switzerland known as the Canton de Vaud. In this region, about halfway between the western end of Lake Neuchâtel and Lake Geneva, lies the little village of Bavois, the cradle of the family from which springs the American branch. Here, for many generations, "Les Agassiz de Bavois" appear to have been small landed proprietors. The family can be traced as far back as 1539, when the name of one Pierre Agassiz of Bavois appears on some public documents. His direct descendant, the Rev. Jean François Agassiz, died in 1681 while he was pastor at Payerne. After him, in direct descent from father to son, there were five generations of Protestant ministers who had parishes in various towns and villages of Switzerland.[1]

The grandfather of the subject of this biography, and last of this long line of ministers, was the Rev. Louis Benjamin Rodolphe Agassiz. The inscription on

[1] A member of this family, David Agassiz, went to Paris with Necker in 1753; and subsequently to London, where he founded the English branch of the family, whose members have occupied honorable positions in the army, the navy, and the civil service. An English Agassiz settled in British Columbia in 1852, where his descendants are still existent.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

a piece of silver given him by the municipality of Orbe, a much-valued heirloom in the possession of a great-grandson, attests that his influence was as great in the schools as in the pulpit. He seems to have been of a liberal turn of mind, for he used to go out shooting early of a Sunday morning, and, returning homeward as the congregation was gathering, it was his habit to lean his gun against the church doorway, when he went in to preach his sermon. He married a member of a family of well-known Swiss physicians, Rose Mayor of Cudrefin on Lake Neuchâtel. A tradition among her descendants declares that in the family councils of her day her firmness of will was the deciding force.

Louis Agassiz, the eldest surviving child of this marriage, was born in 1807 while his father was settled in the parsonage of the little village of Motier on the Lake of Morat, to the east of Lake Neuchâtel. Owing to the slender means of the family, his mother was much opposed to his desire to become a naturalist, so he acquired the foundation of his scientific education while fitting himself to be a doctor of medicine. This double devotion caused his mother no little uneasiness; with much shrewdness she held that, for a penniless boy, the life of a naturalist, delightful if one had an income of fifty thousand francs a year, was little less than sheer madness. So for a short period he actually practiced medicine; it was not possible, however, to keep him long from the path for which nature intended him, and he was soon started on that brilliant career, of which no description is necessary.[1]

While making the rounds of the German universities,

[1] See *Louis Agassiz, His Life and Correspondence*, by Elizabeth C. Agassiz.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

taking a semester here and another there, as is still customary in pursuing a university education on the Continent of Europe, Louis Agassiz fell in with young Alexander Braun, afterwards a distinguished botanist, son of Carl Braun, Postmaster-General of the Grand Duchy of Baden. The two became boon companions, and through the resulting friendship Louis met Braun's sister Cécile, who became his wife, and the mother of Alexander Agassiz.

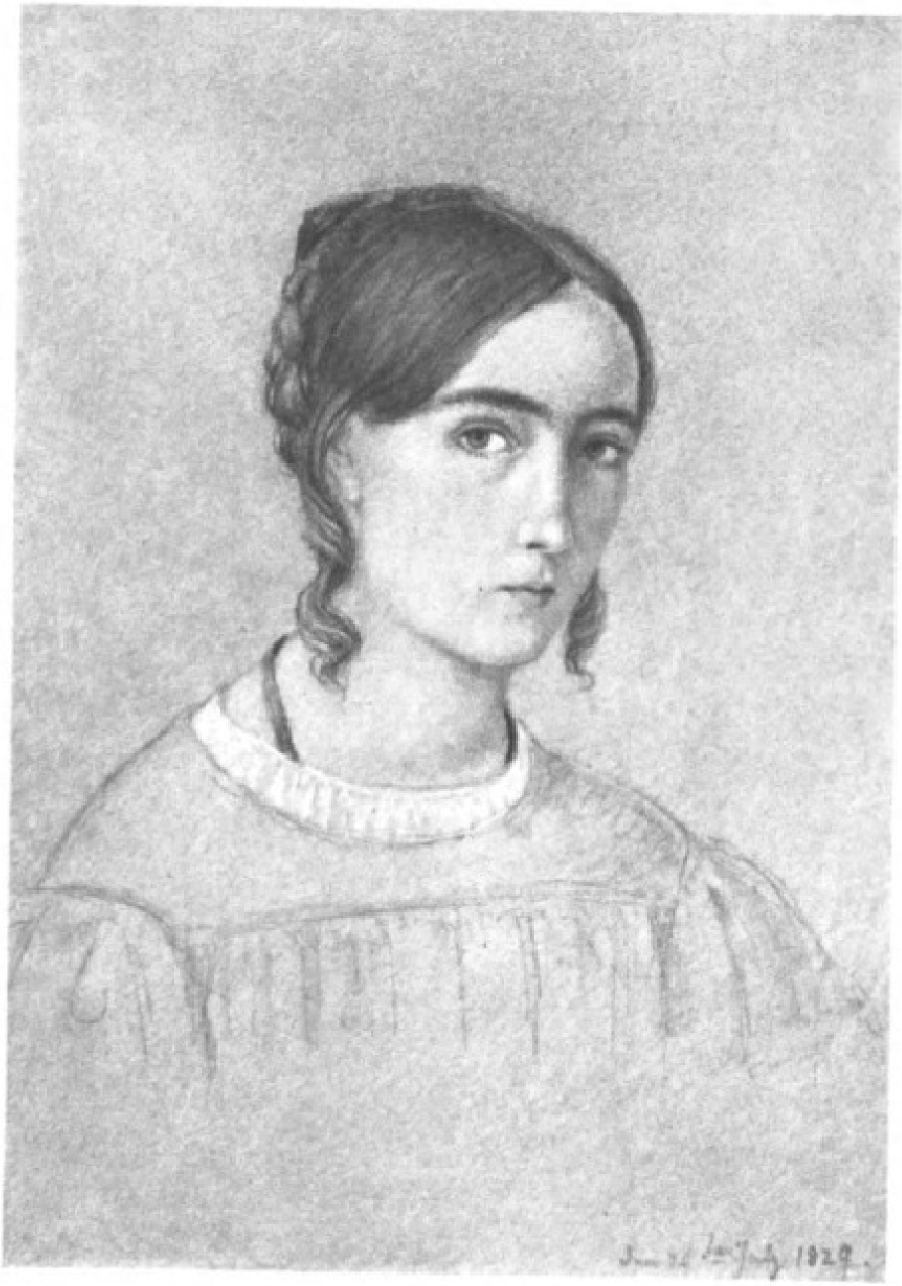
Her father, Carl Braun, the son of a village schoolmaster, was a man of rare sagacity, great energy, and affectionate disposition. His leisure hours were devoted to scientific studies, chiefly astronomy and mineralogy. His wife, a woman of much intelligence and charm, had enjoyed all the advantages of an unusually liberal and careful education. In their spacious house at Carlsruhe their four children[1] lived in an atmosphere that was delightful and unique. The father possessed an admirable collection of minerals and plants, and his sons were provided with work-tables, microscopes, and books of reference. The father's habit of talking over all the questions of the day with his family, the mother's encouragement of everything that could cultivate a love of beauty, made the family life of the Brauns particularly stimulating. Music was one of the favorite pastimes of the brothers and sisters, who were constantly practicing four-part songs, which they sang at home and during their walks.

In such surroundings Cécile grew up, shy, reserved, sensitive, and artistic. Her gifted nature found its ex-

[1] The youngest member of the family, Maximilian, afterward became a noted mining engineer, a fact worth recording in view of his nephew Alexander's achievements in a like capacity.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN



Cécile Brunn
From a drawing by herself

U of M

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

pression in a very rare talent for drawing. The Agassiz family still possess some beautifully drawn portraits from her pencil that are remarkable for an unusual combination of delicacy and vigor. Her son Alexander doubtlessly inherited from her his great facility in drawing objects of natural history with such accuracy and beauty.

After her marriage to Louis Agassiz the couple settled in Neuchâtel where he had been lately appointed Professor of Natural History. Cécile Agassiz never felt quite at home in Neuchâtel; her nature did not easily adapt itself to new surroundings, new circumstances, and a new society. She missed the familiar stimulating intercourse of a home where music, poetry, and literature were part of the everyday life. But she always took a sympathetic interest in her husband's work, and her rare artistic talent enabled her to be of the greatest assistance to him. Some of the best drawings in his "Fossil Fishes," and "Fresh Water Fishes" are from her hand.[1] In her character we have the clue to the curious fact that the elder and younger Agassiz belonged to distinctly different types.

The very general belief that men of unusual abilities inherit many of their qualities from their mothers offers a ready explanation for the marked difference in the characters of Louis Agassiz and his son. Alexander inherited from him a love of science and an extraordinary ability and thirst for work; but his sensitive and

[1] The original drawings of the *Fossil Fishes* are now in the British Museum, for which they were bought at one of Louis Agassiz's frequent moments of financial need. Some years ago when his daughter, Mrs. H. L. Higginson, was examining them there, the young assistant who had been detailed to show her the drawings remarked, "I notice that those signed by the artist 'C. A.' are much the most beautiful."

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN



Lucile Braun
From a drawing by herself

U of M

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

apprehensive temperament he acquired directly from his mother.

Naturally it has been sometimes the habit to compare the two men. But beyond the fact that both had a passionate love of science, pursued by very similar methods of work, and that the son followed in the footsteps of the father in developing the Museum that the latter had founded, they had less in common than might be supposed. The father's optimism was always a cause of anxiety and trouble; the son possessed a singularly clear sight for the rocks ahead, and a very marked ability to steer his course clear of them. The habits of thought of each were necessarily different. Louis was the last of the great naturalists who believed in the special creation of species, and the theological tenets that it implied. Alexander, though always extremely cautious in any speculations that did not rest on a solid foundation of ascertained fact, passed his early scientific life under the stimulus that the teachings of Darwin gave to a new school of science.

The elder Agassiz, buoyant and robust, loved appreciation, was fond of teaching, and had a genius for stimulating his students. More especially after his coming to America he was preëminent as a great teacher. Few people can now realize how intense an interest he kindled in science wherever he went in the New World, or how eagerly people of all kinds thronged to his lectures in communities not easily roused to abstract enthusiasms or given to scientific excitement. Alexander, retiring and reserved, had no gift or desire to excite popular interest; he hated notoriety, disliked teaching, and while his activities extended over many fields, his intellectual life was devoted to research. The essential

Digitized by Google Original from UNIVERSITY OF MICHIGAN

difference between the two men may be suggested in the statement that one was temperamentally a great teacher and the other a great investigator.

Jeffries Wyman, a well-known American naturalist who died in 1874, once said that Alexander Agassiz had already contributed more to the advancement of pure science than his father. If such a statement could be considered seriously then, it must have been much more true in 1910, at the end of an active and busy life devoted chiefly to scientific research.

Louis Agassiz belonged to that type of naturalist which has the gift and the desire to interest the general public. Men of this kind are fortunate in achieving a reputation in some degree commensurate with what is their due. Such men as Alexander Agassiz seldom receive an adequate recognition from any but their peers.

Alexander Agassiz was born on December 17, 1835, in the simplest of little apartments at Neuchâtel. He was the eldest of the three children of Louis Agassiz, a boy and two girls. Curiously enough, it is not certain what really was his full name. As a young man he supposed it to be Alexander Emmanuel Rodolphe, and when he became an American citizen his naturalization papers were so made out. Later in life, however, he discovered among some old family documents a certificate of birth that referred to him as Alexander Rodolphe Albert. His earliest recorded adventure is an expedition he made when only five or six with his mother and her sister to the valley of the Aar, where his father was studying the glacier, encamped on its moraine in a rough stone shelter under a huge overhanging boulder known as the "Hôtel des Neuchâtelois." An old lithograph shows the party clambering up

Digitized by Google Original from UNIVERSITY OF MICHIGAN

to the encampment, with one of the guides carrying Alexander in a large basket strapped to his shoulders.

In due time he went to school at the Gymnase of Neuchâtel. A number of small books, the prizes of his school life, preserved from those days, show him to have been a faithful little scholar. What is known of the early life of the boy foreshadows his later years. He was rather quiet, with the bewitching smile so characteristic of the man. One of his cousins remembers him as very gentle and patient in their noisy games. When she came to play in his house, she saw a certain wardrobe with a drawer where the little chap, already a collector, kept his treasures, mostly mysterious objects in alcohol. Whenever his playfellows approached too near this sacred storehouse, he would exclaim earnestly, "Please don't touch my anatomy!"

Another anecdote relieves one of any suspicion that he might have lacked his full share of a healthy boy's mischievousness, and shows that he developed at an early age his characteristically democratic tendencies. The small boys of Neuchâtel were much interested in politics. They were arrayed in two parties, the Royalists and the Reds. The former, who consisted of the sons of the nobility and "Swells," were devoted to Prussia, and loyal subjects of Friederich Wilhelm; the Reds were Swiss who wished Neuchâtel, like the other cantons, to form part of Switzerland, and resented the authority of the Governor, who was appointed by the King of Prussia. The Governor, a retired Prussian general, and a martinet who liked to show his authority in the smallest details, was so lacking in the rudiments of humor as to complain to Louis Agassiz that his little son was not saluting him politely, and Alex was punished. Meeting

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

the Governor on the street the next day, the boy saluted him in the most abject possible manner. The Governor complained again, whereupon the elder Agassiz, much incensed, gave his son a sound thrashing, for the father was a great admirer of the King, who, at the suggestion of Humboldt, had assisted him in many ways. Not content with this, the Governor singled out his diminutive adversary at a school celebration and held him up for reproof before a large audience.

When it was Alexander's turn to receive his prizes from the Governor, he was so angry that he refused them with scorn, turned his back on the representative of the King, and, to the delight of the Reds, walked out of the room. This led to further difficulties at home.

Infuriated at the Governor's treatment, this youthful patriot collected a band of confederates of his own age, stormed the castle on the night of a large dinner party at which his father was present, and smashed all the windows of the state dining-hall. Louis Agassiz, suspecting the instigator of this outrage, rushed home, but found his son safely in bed and apparently asleep. Commenting on this episode in after years, Alexander Agassiz remarked that it was perhaps fortunate he emigrated to the United States at an early age, as with his views he would surely in due time have been hung or shot.

The salary of Louis Agassiz was entirely insufficient to support his family and publish his scientific works. By 1846 he had exhausted the resources of his relatives, friends, and, indeed, the entire little community of Neuchâtel, who came generously to his assistance. He gladly, therefore, accepted a subsidy from the Prussian Crown, obtained through the influence of Humboldt, to make a scientific exploration in the United States.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Leaving Neuchâtel in March, without his family, he passed some months in Paris among his scientific friends, busy with the publication of his "Système Glaciaire." When this was finished, he went to England, where he was anxious to see his friend Sir Charles Lyell, who, having lately given some lectures at the Lowell Institute in Boston, had arranged with Mr. John Amory Lowell that Professor Agassiz, on his arrival there, should deliver a course. Thus the first link was forged in the chain which bound Louis Agassiz and his son to the New World, and fixed them in the community centred about Harvard College.

In view of her husband's departure, Mrs. Agassiz and her two girls had already joined her brother, Alexander Braun, who was then Professor of Botany at Carlsruhe. For some months, however, Alexander remained at Neuchâtel to continue his studies at Monsieur Godet's boarding-school.

In 1847 he joined his mother at Freiburg in Baden, where her brother had become Director of the Botanical Garden. Here Agassiz went to the Bürger School and was fortunate in coming under the influence of two such eminent men as his uncle, Alexander Braun, and von Siebold, the naturalist, to whom he undoubtedly owed much of his taste for natural history. Professor Braun allowed Alexander to join the excursions that he took with his pupils in the Black Forest, and von Siebold gave him aid and advice in his entomological collection which was sufficiently valuable to induce the savant, by way of payment, to reserve the choicest specimens for himself, much to the disgust of the embryo naturalist.

There was in Freiburg a young clergyman who made it part of his duty to take a number of boys on tramps

Digitized by Google Original from UNIVERSITY OF MICHIGAN

through the Black Forest. On these walking trips the boys put up in farmyards, slept on hay, and lived on bread, butter, cheese and milk, which cost only a few cents. Those who could not stand the life were gradually weeded out, till at the end of each outing the little band consisted only of hardy boys who could easily walk their thirty to thirty-five miles a day. On the last day of one of these expeditions they walked nearly fifty miles to catch a train returning to Freiburg.

Mrs. Agassiz and her little family lived in most straitened circumstances, in a tiny apartment near the Schwaben-Thor, one of the city gates. She greatly loved the quaint old walled cathedral town, and its beautiful surroundings. Although now an invalid, she was still able to take short excursions into the country with her children. Here she would establish herself with her sketch-book, and draw the flowers that her little girls brought her, or likenesses of the peasants, while Alex was busy collecting butterflies or caterpillars, in whose development he was already interested.

The Freiburg winter, with its bracing and sunny air, was an especially happy time for the children. Alexander now became a proficient skater, an art in which as a young man he excelled. Some of the meadows were regularly flooded; and here the boy and his mother spent many happy hours, while she sat in one of the high-backed sleds of that region, which he skillfully guided through the gay crowd of all ages who glided gracefully over the ice.

At home Mrs. Agassiz superintended her children's drawing, and accompanied them on the guitar, for music and drawing were as much a part of the daily life as reading and writing. In accordance with this custom

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Agassiz was made to study the violin, which he loathed. Perhaps practicing in the Cathedral on early winter mornings, when his hands were so numb that he could scarcely hold the bow, did not tend to lessen his distaste; especially as, when he was too cold to play properly, his teacher used to rap him over the knuckles for not doing better. At all events, he never touched a violin after coming to America. Although he disliked music, he remained an excellent judge of it, and no one could have been more sensitive to a false note; but he preferred silence to the best of music, and bad music he found insufferable. In the happy days of his married life, however, it was not uncommon to hear him, while busy over his work, unconsciously whistling the latest air in perfect tune. He was said to be a good critic of the technique of the violin: once toward the end of his life, when crossing the Pacific, he went up to the first violin of the orchestra, that now deepens the gloom of a dinner at sea, and asked him where he had learned to bow, as that was the way they taught youngsters in Freiburg when he was a boy. A dislike for music is probably not so uncommon as many people suppose, but it is seldom found in connection with so much knowledge of the art.

Some one had given the children of the little family at Freiburg all the volumes of Schubert's "Natural History," full of colored plates of animals drawn to scale, with explanatory text. One of their favorite amusements was to take very large sheets of paper on which they copied these illustrations, increasing them with a pair of compasses to their natural size. When they had made a sufficient number of pictures, they would pin them on the wall of their playroom, learn the text by heart, and hold an exhibition. One groschen was

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

the price of admission to the entertainment, which consisted in the reciting of the text appropriate to each illustration.

The most exciting of Alexander's experiences at Freiburg occurred on Easter morning, 1848. It was the year of the Revolution that swept over Germany. The insurgents held possession of the town, while the government was massing troops outside, to meet Hecker's expected approach. Mrs. Agassiz was seriously ill in bed, and did not realize the gravity of the situation. Unable to celebrate the Easter holiday with her children, she allowed them to go to their Uncle Alexander's, who lived about two miles outside the city. No sooner had they arrived at their uncle's than firing was heard, and they were sent back. Their walk home was through a scene of great confusion, squads of soldiers marching hurriedly, men on stretchers, people shouting, "Hecker is coming! Hecker is coming!" On reaching the city gate they found it barricaded. The girls began to cry, but their small protector kept quite cool, opened negotiations with those on the inside and persuaded them to let the little noncombatants in. When at last safely at home, they bolted the doors, closed the shutters, and lighted candles. The girls tried to busy themselves at their mother's bedside, and through the chinks in the closed blinds Alex watched the capture of the town by the government troops. Several cannon-balls fell into the attic, and the blind through which he was looking was grazed and broken by a ball which made his cheek feel hot as it whizzed past.

As Mrs. Agassiz became weaker, the thoughtful child grew more quiet and serious, for he adored her and must have realized that her end was near. He now took

Digitized by Google Original from UNIVERSITY OF MICHIGAN



ALEXANDER AGASSIZ AT THE AGE OF TWELVE

From a drawing by his mother

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

charge of the pathetic little household, kept the small accounts, did the errands, went to market every day, and strove like the true mite of a man that he was to relieve his mother of anxiety. In the summer of 1848 she died and the children were taken to their Uncle Alexander's. Soon letters arrived from the father in America, directing that the girls should return to their aunts in Switzerland, while it was arranged that Alex should remain with his Uncle at Freiburg.

After his mother's death, Agassiz passed his vacations with his Swiss relations. Not being able to pay the stage fares, he trudged back and forth between Freiburg and Neuchâtel or Lausanne, passing his nights under a haystack or in the house of some friendly peasant, "and almost anybody would give such a tiny traveler a piece of bread or bit of cheese" — he used to say.

In the spring of 1849, after he had lived nearly a year with his uncle, he was sent for by his father, who was now settled as Professor of Natural History at Harvard. Hearing that America was a land of freedom where one could do what one chose, Alexander celebrated his departure from Freiburg by jumping on his violin as he set out for the New World.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

CHAPTER II

1849–1860

FIRST YEARS IN AMERICA

As there was no railroad between Neuchâtel and Paris in those days, Agassiz and Mr. Felix Marcel, in whose charge he was placed, made the journey by diligence. Here Alex joined his cousin, Dr. Charles Mayor, who, on account of religious persecution, was leaving Switzerland with his family to settle in the United States. At that time it was thought far safer to cross the ocean in a sailing vessel, rather than in one of those new-fashioned contrivances, a transatlantic steamer. The party accordingly embarked at Havre in the French ship Le Joseph, and endured a tedious passage of forty-five days to New York, which they reached sometime in the summer of 1849. On his arrival Agassiz was met by his father, who at once took him to Cambridge. From here Louis Agassiz writes to a friend, "Je reviens de New York avec mon fils, c'est vous dire que je suis bien heureux maintenant. C'est dans toute la vérité de l'expression et à part de la partialité paternelle un charmant garçon."

Shortly after the boy reached Cambridge, his father took him to Nahant, then the favorite seaside resort of the Boston Brahmins, where he met some lads of his own age, sons of his father's friends. Alex could not speak any English, but the boys managed to make themselves understood in Latin! Fond as the Romans were

Digitized by Google Original from UNIVERSITY OF MICHIGAN

of bathing, when it came time for a swim, their language was found inadequate to convey the idea, so the invitation was given by waving a bath-towel.

Agassiz soon imbibed the atmosphere of freedom of his adopted country, and could hardly realize that it ever had been possible for a small boy to be nagged and punished for political opinions. In the fall of 1849 he was sent to the Cambridge High School to prepare for college. This was a famous school in those days; although one of the few schools from which one might enter college, it still made its chief object the education of its pupils. Louis Agassiz gave there an annual course in Natural History, and special attention was paid to instruction in Physics and Chemistry; the small laboratories being better than those then existing at Harvard.

Professor Agassiz's little house on Oxford Street must surely have seemed a strange home to the small foreigner. The household, besides the father, consisted of a dear old artist, Mr. Burkhardt, a young Harvard student, Mr. Edward King, an old Swiss minister called "Papa Christinat," who was supposed to look after the housekeeping, a bear, some eagles, a crocodile, a few snakes, and sundry other live stock. These last enlivened the home life in various ways. Sometimes there was a wild chase to capture the eagles, or a hunt to discover in what corner of the house the snakes had hidden themselves. Once, when there was a large party at dinner, an uncertain and heavy tread was heard upon the cellar stairs, and Bruin, having broken his chain, and broached a cask of wine, lurched into the room.

This erratic household lasted until the spring of 1850, when Louis Agassiz brought home his second wife, Elizabeth Cary. She established order out of chaos, sent

Digitized by Google Original from UNIVERSITY OF MICHIGAN

for the two children abroad, and made her house one of the centres of the intellectual life of the day. From the first she went straight to the heart of the motherless boy, and she stayed there for the rest of her life, his devoted friend and companion.

It is to this second mother that Louis Agassiz's three children owe the happy home they found in the New World, and the pleasant and interesting life that sprang up about it. She was the wise spirit who guided the family and presided over its varied interests with unfailing cheerfulness and courage. Her constant concern and sympathy in all that related to her adopted children never failed. The place that she won in their lives in the beginning, she held to the end. To their children and grandchildren, superior beings in her loving eyes, the wonderful influence of her tender solicitude is an abiding memory.

Cambridge was then the centre for a small group of very distinguished men. Louis Agassiz's brother-in-law Felton, Peirce the eminent mathematician, Child the English scholar, Asa Gray and Jeffries Wyman the naturalists, Longfellow and Lowell, were at home in the Agassiz house, and the talk that flew about was a liberal education.

Some member of the college staff was constantly dropping in. It might be Professor Peirce to ask the young people to come over to breakfast with his mother, or to bring some mathematical puzzle, which Alex invariably solved. Sometimes Professor Child would appear with a college theme for the girls to try their hand at.

The visit of an eminent foreign savant was no unusual event. Some of them must have furnished endless amusement for the younger members of the household,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

and been sore trials to the decorous New Englanders who frequented the house. Once a distinguished visitor came to pass the night. As he apparently lacked all the articles generally considered indispensable to the shortest visit, he was asked if he wanted anything. To this he contentedly replied, "Non, non — Ah! un peu de pommade, s'il vous plaît."

On another occasion the son of the great Ampère came to pay an afternoon call and stayed several weeks. He proved to be a man of wide information and a delightful and entertaining guest, but he had his little peculiarities. After a few days he bethought him to send for his baggage, a small hand satchel containing an amazing quantity of scientific treasures. It was his custom on Sunday to appear in a gorgeous expanse of white shirt front. As the week advanced, this gradually disappeared beneath a more and more closely buttoned coat, to emerge again in full splendor on the following Sunday.

The winters were full of gayety and merriment. In the evening there were pleasant sociables at different houses; in the daytime an hour or two could always be found for skating on Fresh Pond. Here Agassiz and his sister Pauline skated together with a skill and grace that were celebrated in their day. Certainly the Cambridge life of those old times had a delightful quality of its own. Every one enjoyed so many things with his neighbors that it seemed as if they were all living together in a happy family circle. If there were a reading by Mrs. Kemble, or something new at the Boston Museum, where Warren acted to delighted audiences, or if Booth were to play, the community hired an omnibus, and everybody who could go, went. Afterward over a pleas-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

ant, simple supper at somebody's house in Cambridge, the gay gathering would discuss the event of the evening. There were private theatricals at Mrs. Charles Lowell's, and German plays in which Alexander acted. Were there a party in Boston, or theatrical entertainments at the Cushings' in Belmont, or at the Cabots' in Brookline, the omnibus again came forth, and the fun and expense were shared by the neighbors.

The winter vacations in those days lasted six weeks. This enabled Louis Agassiz to accept an invitation to deliver a course of lectures at the Medical College at Charleston, South Carolina, during the winters of 1851–52 and 1852–53. Here the family were most hospitably received in the homes of the Rutledges and Holbrooks, where young Agassiz got some experience of plantation life on the Santee River.

Mrs. Rutledge, "the most stately and hospitable of Southern matrons," had given the Professor, for a laboratory, the use of her pleasant cottage on Sullivan's Island. Here, "within hearing of the wash of the waves, at the head of the beautiful sand beach which fringed the island shore," the boy spent much of his time with his father, studying and collecting.

During these visits Alexander Agassiz made a number of warm and fast friends, so when civil war swept over the land, sympathy for them was one of the reasons that prevented him from joining the Federal army.

Mrs. St. Julien Ravenel, of Charleston, a lifelong friend, in writing, shortly after his death, to his sister Mrs. Higginson, says of those days: "I always think of him, altho' I have seen him often since, as the charming boy who came, fresh from Switzerland, and spent part of a winter here with your father, Count Pourtalès, and

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Mr. Burkhardt. He was so different from other boys and so delightful, a most charming boy — just at the age when boys are so seldom charming, and I, only three or four years older and not yet married, was a good play-fellow for him. Dr. Ravenel delighted in him and always predicted distinction for him. We taught him to ride (he as 'a Switzer' had never learnt), and to paddle a canoe, and go crabbing, and had very gay times with him at my aunt's little country place, 'Belmont.' Then he went to college and I never saw him again for more than twenty-five years. He was a grave quiet man then (not long after his wife's death), and I spoke to him as 'Mr. Agassiz,' but he smiled and said, 'You always call me Alex.'"

Do men mature faster in the shadow of the Alps, that certain qualities, which made such a marked and distinguished personality of the man, were already so evident in the boy? For this quiet youth already possessed an unusual power of concentration, and a gift of accomplishing what he intended to do. The thoroughness and ease with which he worked, his great reserve, his sudden explosions of indignation, his quiet and entire devotion to those he loved, his occasional outbursts of mirth, as delightful as they were unexpected, his unfailing charm, — all these belonged to the Swiss boy no less than to the scientific man of cosmopolitan friendship and fame.

In the fall of 1851 he entered Harvard, at the age of fifteen and a half, with the class of '55. His classmates included such well-known men as E. H. Abbot, R. T. Paine, F. B. Sanborn, Theodore Lyman, Professor J. K. Hosmer, Judges Mitchell and Seawell, Bishop Phillips Brooks, and Francis C. Barlow, the first scholar of the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

class, who entered the Civil War a private, and left it a major-general.

While in college Agassiz lived at home, first on Oxford Street, and later in the house on Quincy Street, opposite the northeast corner of the College Yard. This, with the exception of a few years during his married life, was his home for the rest of his days.

Thanks to the thoroughness of his European training, he was able to read Latin and Greek better than most of his classmates. Many years after their graduation, Theodore Lyman said of a long-winded Latin oration at some solemn public function, "I'll bet Alex was the only man who understood it." Agassiz had, however, no natural sympathy for the classics, and the scientific trend given to his early studies had intensified a dislike of the subtle analysis of language and the dryness of grammatical hair-splitting, fatal to a high place in his class. But in the subjects that interested him he was preëminent, studying mathematics under Peirce, and working hard at chemistry under Cooke in the more than modest laboratory in the basement of University Hall.

Already his well-trained mind was capable of long application, and the hours he usually devoted to work would have crushed the easy-going undergraduate of to-day. Nor was his time entirely given to subjects connected with the curriculum, for a beautiful set of drawings on wood intended for an unpublished textbook of his father's, attests his interest in natural history.

Even at an age when philosophy usually has such a charm for an active mind, it held no interest for him. Possessing to the fullest extent the dislike of metaphysical speculation so common among men of science, and already, unlike most of them, a man of action, he

Digitized by Google Original from UNIVERSITY OF MICHIGAN

devoted himself to the study of the knowable, and left groping among the intangibles to others. With this trend of mind, with too fearless a nature, and of too sturdy a morality to feel the need of religious support, it is natural that he early adopted an attitude toward the infinite now so common among scientific men. His views on religious matters are perhaps best illustrated by Huxley's well-known opinions on such questions, for Agassiz had almost as little sympathy with the speculations of Haeckel as with the most orthodox dogmas.

Those were the days of small classes, when it was possible to know all one's classmates and to be intimate with many. Although younger than his companions, he was a great favorite with them, and was known by the name of "Swiss." He entered with much enthusiasm into the theatricals of the Hasty Pudding Club, where among its archives many of his posters and drawings are still preserved. As president of the Natural History Society he took a considerable interest in its meetings.

It is an evidence of his many-sidedness, that, too poor to accept an election to the Porcellian Club while in college, he was after graduating made an honorary member of that institution, noted for its good fellowship and *esprit de corps*, where natural history was seldom the topic of conversation.

Agassiz was of medium height, dark, and at that time rather slight, though remarkably powerful and active. There is still in existence an enormous pair of Indian clubs, so heavy that the average man can hardly hold them at arm's length, which he used to swing. Then as now regattas and examinations were apt to conflict, and his fondness for rowing may in part account for his

Digitized by Google Original from UNIVERSITY OF MICHIGAN

not graduating higher than twenty-fourth in a class of eighty-two.

He pulled bow on the University Crew, at about one hundred and forty pounds, a position that he also filled while in the Scientific School. Rowing was managed in a simpler way in those days, when the only distinction between an amateur and a professional was, that one was a gentleman who rowed for pleasure, and the other an individual who did so as a business. It is refreshing to learn that the members of the University Crew of the day bought, out of their own pockets, the first racing-shell ever seen at Harvard.[1] On its arrival in Boston, they carried it across the city on their shoulders, and reimbursed themselves from the prize which they won, from the best professionals of the day, at the next regatta on the Charles.

This crew, by the way, made crimson the Harvard badge. In order that it might be more easily recognized, one of its members, Charles W. Eliot, the future President of the University, bought some crimson handkerchiefs in Boston. These the oarsmen bound on their heads, thus establishing the college color.

Agassiz retained his interest in rowing all through life; even in his last years he could judge a crew at a glance and pick out its weak points with singular accuracy and swiftness. Occasionally he would appear at the Museum so hoarse that he could scarcely speak; then some one was sure to ask him how he caught such a bad cold. An expression of shyness and sheepishness would steal over his face, and he would explain that he had been to a boat-race and fancied he must have shouted rather too loud.

[1] The bow of this boat now hangs in the west room of the Harvard Union.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

The four years of hard work, athletics, and simple pleasures sped quickly. Class Day at Harvard was a very different affair in those times. The Cambridge belles of the day tied with their own hands the wreath of flowers that was wound high up around the classic tree behind Harvard Hall. Under the eyes of a gay and eager throng clad in its best, the class in its oldest clothes gathered in a circle about the tree. The chief marshal threw his hat in the ring as a sign for the fray, and there was a wild struggle for a bit of the historic wreath. There were simple "spreads" in the students' rooms, there was dancing on the college green, and the undergraduate life of the class of '55 was a memory of the past.

On leaving college, Agassiz entered the engineering department of the Lawrence Scientific School. Here, devoting himself entirely to congenial subjects, his real ability asserted itself. He graduated in 1857 with a *Summa cum Laude*. Then he turned his attention to chemistry, occupying a desk in the laboratory under Professor Horsford. On his return from the West, when settled at his work in the Museum, he took another degree at the Scientific School in 1862, this time in natural history.

His father's affairs, notwithstanding the fostering care of the son, were in a more than usually deplorable muddle shortly after Agassiz left college. Louis Agassiz possessed but a hazy idea of the value of a dollar, and the modest funds of the household budget had an alarming way of converting themselves into alcoholic specimens at the most inopportune moments.

In order to retrieve the family fortunes Mrs. Agassiz proposed, with the assistance of her stepson, to start a

Digitized by Google Original from UNIVERSITY OF MICHIGAN

girls' school. The upper story of the house was converted into schoolrooms, the recitations were to overflow into the other stories. The unrivaled reputation of Louis Agassiz as a great and inspiring teacher immediately made the school unique and gave it an unqualified success. It became the girls' school of its day; special omnibuses brought the pupils out from Boston; while parents in other parts of the country made arrangements for their daughters to live in the neighborhood, that they might enjoy its special advantages.

In speaking of the scope of the school the elder Agassiz said, "We will teach the girls everything but mathematics, and the poor things can learn that almost anywhere else;" a remark hardly just to the son, who unlike the father was an excellent mathematician.

Those were busy days for Agassiz, who, while pursuing his studies at the Scientific School and the Chemical Laboratory, prepared the tabular view of the studies of the school, kept the books, and paid the teachers, besides teaching the girls mathematics, chemistry, physics, French, and Latin.

It was a trying experience for a young man of twenty, to teach with dignity and success a school full of girls, some older than himself. Many of his sisters' friends were pupils in the school, and it must often have been difficult for him to forget that the night before he had danced with them in Boston or Cambridge.

In 1857 there was a celebrated race between the Volante, a crew composed of well-known young men about town, and the university crew of which Agassiz was still bow. His pupils and two thirds of Boston lined the "Back Bay," and watched the defeat of the Harvard boat after an exciting struggle. The next morning at

Digitized by Google Original from UNIVERSITY OF MICHIGAN

school many of the girls appeared wearing black ribbons on their arms, and for once, as he walked to his desk, the young master gave them a smile.

He always disliked teaching, and as by 1859 the school was firmly established, he began to look about for some other means of earning a livelihood. Warned by his father's example of the dangers that beset the path of a scientific enthusiast of slender means, Agassiz had at this time no intention of embracing the career of a naturalist. For he had fallen in love with one of his pupils, and was anxious to place himself in a position to be able to marry.

Naturally turning to the profession of engineer, for which he had fitted himself, he obtained the position of aid on the Coast Survey, through his father's friendship for Professor Bache, then its superintendent. At once he left for San Francisco to report to Mr. Lawton on board the Fauntleroy, destined to spend the summer in the Gulf of Georgia and survey the boundary between the United States and British Columbia. After his departure it was noticed that the young lady, who later became his wife, adopted a very frugal method of life, as if fitting herself to be the companion of a poor man.

He reached Colon on one of the wretched and dirty little steamers of the Vanderbilt line, and crossed the Isthmus of Panama, a region that later became familiar through frequent visits, where he got his first view of the splendor of a tropical forest, — an impression that he never forgot.

While waiting in San Francisco for the Fauntleroy, he went up on a coast steamer to Crescent City to survey the bay. Here the Fauntleroy picked up the party and they had a wretched passage to the Straits of Fucca.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Owing to the foggy weather but little surveying was done; as there were practically no observations to work up, this left the day free. Agassiz was never a man who could spend the time doing nothing; so in self-defense he turned to the study of marine animals, making notes and drawings which he sent to his father to show the character of the fauna. Copies of these letters, written in French and too technical to be given here, are preserved in a crumbling old letter-book. They show a wide familiarity with the subject, remarkable in a young man of twenty-four who was just starting life as an engineer.

It was while cruising in these waters that he first learned of the existence of the Canadian branch of the family, through the letter of an irate stranger who wrote, "Unless you take your d—— sheep off my ranch, I will shoot you at sight."

On another occasion his restlessness of mind got him into a scrape that only his skill as an oarsman saved from being a tragedy. While the Fauntleroy lay anchored somewhere in the Gulf of Georgia doing nothing, he put off by himself in a light boat, came across an Indian graveyard, and stepped ashore to inspect it. After a time he chanced to look up and saw two canoes filled with Indians racing for him from different directions. He jumped into his boat, but was no sooner under way than he quickly saw that the canoes were approaching at such an angle as to be sure to intercept him. It meant death to be caught, and he instantly formed a plan of escape. Rowing along steadily he reserved his force, and waited till the canoes full of shouting savages were close upon him; then with a tremendous spurt he slipped out between their bows. The canoes came

Digitized by Google Original from UNIVERSITY OF MICHIGAN

together with a crash, and in the confusion a few powerful strokes put him beyond their reach.

In the late fall the Fauntleroy returned to San Francisco, where she was delayed a week or so off the Heads. Again he filled his idle moments, and devoted himself to the study of the Discophorous Medusæ so common on the coast. While in San Francisco he made in the bay a collection of the Viviparous "Perch" (Embiotocidæ), first discovered by Mr. A. C. Jackson in 1852 when exploring those waters in search of a suitable spot for a naval station. Several dozen beautifully colored drawings of a number of these "Perch," made by Agassiz at the time, are still in existence, but have never been published.

As there was no work to be done by the Coast Survey during the winter, he obtained leave of absence to accept an invitation of the superintendent of the Pacific Mail Steamship Company to be his guest at Acapulco and Panama.

After a visit of some three months at Panama, Agassiz concluded that his humble post offered no immediate prospect of marriage. So he sent in his resignation, little dreaming that in after life he should refuse an earnest request of the President of the United States to accept the highest position in the Coast Survey.

The call of heredity was in Agassiz's blood; closing his transit he made, straight as a homing pigeon, for his father's Museum, which he ever afterwards made his headquarters.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

CHAPTER III

1860–1866

THE MUSEUM BECOMES HIS HEADQUARTERS

On his return from California, Agassiz was appointed "Agent" for the newly established Museum of Comparative Zoölogy. For this position the salary, fifteen hundred dollars a year, was given to the Museum by Theodore Lyman, a pupil of Louis Agassiz and a classmate of his son. Thanks to this generosity, Agassiz now found himself in a position to marry Anna Russell, the daughter of George R. Russell, a well-known East India merchant of Boston.

The marriage took place in the fall of 1860; as the bride's family was in Europe, the ceremony was celebrated in Brookline at the house of her sister, Mrs. Theodore Lyman. Being too poor to have a home of their own, the young couple started life with Professor and Mrs. Agassiz in the Quincy Street house. These early years of Agassiz's marriage, crowded with work, were undoubtedly the happiest of his existence, for always after that his life was clouded with ill-health or sorrow, and most of the work of his later life was accomplished under the shadow of both.

Although obliged to practice the most rigid economy, there was no shadow on his life then. He rejoiced in his scientific work, and appreciated good company. Existence was simple in the sixties, and his tiny income did not imply the restrictions it would now necessitate.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN



Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

[illegible]

On [illegible] California, [illegible] "Agassiz [illegible] Com- parative [illegible] for this post [illegible] fifteen [illegible] year, was [illegible] by [illegible] pupil of [illegible] thanks to [illegible] Agassiz [illegible] Russell, [illegible] a well known East [illegible]

[illegible] of 1860; as he [illegible] These [illegible] with work, [illegible] existence, for [illegible] his life was clouded with ill-health [illegible] the work of his later life was [illegible] both.

[illegible] economy, [illegible] in his [illegible]



Anna Russell

U of M

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

At times so gay and entertaining, he possessed, like his father, that indefinable quality of charm which made him welcome everywhere. Years of sorrow never quenched that charm or deadened his genial hospitality.

His sister Pauline had married Mr. Q. A. Shaw and was living near by in Jamaica Plain. His wife's relatives were widely scattered throughout Boston; both she and her husband had a large circle of friends, and their opportunities for seeing pleasant people were far greater than the time that either could devote to them. In writing of those days Theodore Lyman says, "I do not know of any married man who could look back on better years, except the money." For the younger Agassiz was never able to accept a life cramped from lack of funds, with the elder's happy philosophy.

Unlike his father as he was in many other ways, the son nevertheless inherited his unusually quick temper. Although his characteristic outbursts of indignation became less frequent, and were much softened with advancing years, yet this readiness to righteous wrath was not wholly irresponsible for the numerous serious *mêlées* in which he became involved at various times, adventures that would have immersed most men in endless difficulties, but from which with ready resourcefulness he always contrived to emerge triumphant.

An example of this, in his later life, comes to mind now. On one of his visits to Berlin he went one evening into a restaurant, sat down at a table and ordered dinner. A few moments later a party of officers took seats at a neighboring table, and his waiter at once devoted himself to them. Agassiz called across to the waiter that he was waiting for his dinner, whereupon one of the officers came over to him and arrogantly called

Digitized by Google Original from UNIVERSITY OF MICHIGAN

his attention to the fact that the man was waiting on them. Agassiz remarked that he was not speaking to him; the officer handed Agassiz his card; the latter tore it up; the officer started to draw his sword, but, before he could get it out of the scabbard, Agassiz knocked him down with a chair. In the confusion which followed, he jumped into a cab, drove to the embassy, and stated his case. The upshot of the matter was that the officer was forced to apologize.

Sometimes his anger warped his judgment, a weakness of which he was not unconscious. For after writing a letter in a moment of excitement, it was often his habit to keep it till the next day, and then destroy it. Occasionally his indignation was not wholly reasonable, but it took such whimsical turns that it endeared him the more to his friends. One day at Newport he was looking over some charts with one of his sons and discussing his next trip. It so happened that the latter had not been in Newport for several years. Suddenly Agassiz looked up and beheld in the distance a buggy tied to a tree, and a couple of men fishing on the rocks.

"There," said Agassiz, "they are at it again! The way everybody drives all over the place and ties his horses everywhere is perfectly outrageous. The worst of it is that when they are spoken to, they are so insolent!"

With that he stalked off toward them, and was well across the lawn before the thought that he might need protection from the insolence of these intruders occurred to his son. When he finally came to his father's aid, he found him upbraiding the trespassers for their iniquities in plain Anglo-Saxon. These unfortunates, whenever they could get a word in edgewise, endeavored

Digitized by Google Original from UNIVERSITY OF MICHIGAN

to make the most abject apologies, while their attitude suggested a caterpillar, who when poked with a stick curls up and tries to disappear. As quickly as possible they got into their buggy and drove off, two deeply humiliated men. Then Agassiz turned to his son and observed in perfect good faith, "You see how insolent they are!"

Before speaking of the early work of his scientific life, it might be well to say a few words in regard to the origin of the institution with which it was ever afterward connected. The elder Agassiz on settling in Cambridge had stored his treasures in a shanty built on piles on the marshes of the Charles River, close to the bridge that now leads to the Harvard Stadium. In 1850, the collections, having outgrown this primitive shelter, were removed to a wooden building on the site of the present gymnasium. By 1852, the care of the collection had grown to be more than the very modest means of Louis Agassiz could meet, and a fund of $12,000 was raised by private subscription to purchase it for the college. The expense of its charge, however, still remained in his hands, and he devoted untiring enthusiasm and ingenuity to increasing and maintaining the specimens.

In 1858, the Corporation of Harvard College made a small allowance for the care of the collections, and in the same year, $50,000 left by Mr. Francis C. Gray to found a museum, was placed at the disposal of the elder Agassiz, under the condition that the institution should always be known as "The Museum of Comparative Zoölogy." Accustomed to the European method of seeking government aid, Louis Agassiz went to the State Legislature, and to every one's amazement extracted $100,000 from those hard-headed New Eng-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

landers, while at the same time a further fund of $71,000 was raised by private subscription. Armed with these resources, he built what was then intended to be, and now actually is, a portion of the northeast wing of the present huge structure. This first section of the building was completed in the spring of 1860. The personnel of the Museum was planned much after the organization of the Jardin des Plantes. Many of the early assistants later became professors at Harvard or other universities, or were placed in charge of museums, which were afterward established all over the country.

Alexander Agassiz's position, besides giving him the care of the department of Radiates, included the general charge of the work and business of the institution. This involved a vast amount of mechanical labor in arranging and storing the immense mass of material which poured in from all sides; for the plans of Louis Agassiz were always on a huge scale, far beyond his resources in men and money. To this was added the establishment and care of all exchanges, and the disentanglement of the financial difficulties into which the cheerful optimism of his father constantly plunged not only the Museum, but also the family purse.

The following letters, selected from his correspondence of that time, may give some suggestions of how eager and many-sided was his activity in developing the relations of the Museum with other institutions, in making exchanges of specimens, and in stimulating the interest and coöperation of scientific men in all parts of the world.

The first is to the leading physician in Santa Barbara, whose acquaintance he had made in California.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

TO DR. J. B. SHAW

CAMBRIDGE, Apl. 13, 1863.

My friend, Mr. Levi Parsons, tells me that you have been kind enough to offer to make collections for us here. I cannot allow my letter to him to go without thanking you sincerely for your efforts in behalf of our Museum, and I shall look forward with pleasure to the time when we may receive something from you. We have absolutely nothing from Santa Barbara and that region, so that everything you find, no matter what it is, provided it creeps on land or swims in the water, or flies in the air, is acceptable. Be not afraid either of sending too many specimens. They are always valuable for exchanges. I shall in the course of a few weeks send you a few circulars containing directions for collecting; we are at present out of them and wait for the printers. In the meanwhile I would call your attention to a few animals of which we shall desire especially to have specimens at this time: they are the starfishes, sea-urchins or sea-eggs as they are called, all kinds of corals, of which I hear there are several species in the channel. As all these things are preserved dry, as well as in alcohol, they will be but little trouble. Before being set in the sun to dry it would be a good plan to dip them into hot water; this kills at once and removes all the salty matter. The beaches after a storm are good localities for collecting masses of dried shells, starfishes, sea-urchins, corals, thrown up by the waves. The fishermen's seines when drawn up leave crabs, etc., on the beach of no use to them. The fish market is the simplest way of getting a good collection of fishes.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

TO C. B. RICHARD & BROS.

CAMBRIDGE, May 24, 1864.

GENTLEMEN: —

I forward to-day to you per Adams Express 9 boxes, 8 of which contain live-stock to be forwarded to Prof. H. Milne Edwards, Jardin des Plantes, Paris, France, care of H. L. Müller and Cie., Havre. The food of the animals is marked on the boxes, but to make sure I repeat here:

No. 1 contains Reptiles and needs no care except air.
2 contains a Marten; needs scraps of meat and water.
3 a Lynx; needs same food as No. 2.
4 & 5 contain Squirrels; need nuts, scraps of bread, corn and *water*.
6 Woodchuck; eats turnips, raw potatoes, scraps of vegetables and *water*.
7 Owl; needs only meat.
8 Eagle; needs meat and water.

If these animals are fed once a day it is enough except the woodchuck, No. 6, which had better be fed twice. I send in the ninth box nuts, turnips and corn for the food of the squirrels and part of the food of the woodchuck. I suppose of course that scraps of bread and the necessary remnants of *fresh meat* can be obtained on board the steamer by the person who has charge of them. The lynx ought to be bothered as little as possible; it is a female with young and she is rather cross on that account. I suppose the cages of the lynx and of the woodchuck ought to be cleaned about once in four days, if they get offensive, and clean hay or straw put in. This can easily be done by means of a poker to scrape out the old hay.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Hoping that this small menagerie will have a favorable passage, I remain,

Yours very truly,

ALEX AGASSIZ.

TO J. J. KAUP,[1] DARMSTADT

CAMBRIDGE, Feb. 25, 1865.

Your note of January 10, addressed to father, has been received some time and as father has not written you for so long, he wishes me to answer you that you may not think he has entirely neglected your affairs. He is very much pleased at your continued exertions in behalf of our Museum and hopes that the invoices we have made have been acceptable. You say nothing in your letter of the Echinoderms which were sent about the same time with the turtles and in which I had put a package of shells selected for you by Mr. Anthony. We feel quite envious of your Dinornis bones and hope that the time may come when you may spare us a skeleton or a cast at any rate. Speaking of casts, father is very anxious to have a suite of your magnificent casts for our Museum; but unless we can have a little time to pay for them, till gold has come down again to reasonable prices, he hardly dares to ask you for them. We have thus far done so little to please the public and have sacrificed the wishes of the common populace for so long to the demands of strict scientific investigations, that he feels it is about time for him to do something in that way, and as this combines the demands of the public and of the scientific men, he can hardly apply his means to a better purpose. We shall be able to supply

[1] A zoölogist of note, most of whose published work relates to birds and fishes.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

your wants of N. American insects during next summer and in the fall we shall try to make you a good invoice. We have a very good and conscientious entomologist (P. R. Uhler) at work at the Museum who will do all that can be done and to whom the collection of Coleoptera you are about sending will be particularly welcome. As you see by the papers, our prospects to finish the war during this year and reduce the whole to a mere insurrection are quite good and from your letter I judge that the news we have been sending to Europe the last few weeks has been very welcome. I trust your prophecies about Maximilian will come true, and that the Monroe Doctrine and the Star Spangled Banner will yet reign supreme over the whole of North America, in spite of John Bull and Napoleon.

At the outbreak of the Civil War most of the Museum assistants left to join the Federal army. As Agassiz was only recently naturalized, and could not forget his warm friends in the South, he concluded to stay at home and prevent the disintegration of the Museum. With his temperament, it must have been a sore trial for the young naturalist to find his share in the bitter struggle confined to eagerly watching the progress of events. When it became apparent that the war was drawing to a close, he thankfully rejoiced with those at home who hoped soon to see the end of much misery and a reunited people.

After the fall of Richmond, the assistants, who had returned to the Museum, were again drafted, but this time to follow Professor and Mrs. Agassiz to Brazil. The voyage, at first contemplated chiefly for the sake of Louis Agassiz's health, had developed, thanks to the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

generosity of Mr. Nathaniel Thayer, into a scientific exploration of the Amazon on a considerable scale. The departure of his father in April, 1865, left Alexander Agassiz in sole charge of the Museum, until the return of the party in the summer of 1866.

In writing to Professor Kaup about this time, after telling of his father's journey, he says: "Of course this general riddance of all the assistants here leaves me entirely alone to look after this immense Museum, and I can hardly hope to do more than take care of what comes in." The letter concludes: —

"I can read German as well as English, but I do not like to write German except when necessary, and as I suppose English is perfectly familiar to you I write in English. I so rarely have occasion to practise my German either by writing or speaking, that it gets very rusty and I of course prefer to use English when I can as it comes more naturally. We all feel (at the North) in a splendid condition and high spirits after all our late successes. *Lee*, Richmond, Johnston, have all surrendered. The war is *finished* this side of the Mississippi and the Rebels across in Texas are already talking of surrendering. Our French and English friends had better take care how they allow any more rebel vessels round about their harbors or they may get punished for their past impudence."

The first few lines of the following letter refer to a difficulty with which most of Agassiz's correspondents had to contend, for, unless well accustomed to his handwriting, it was no light matter to decipher one of his letters. This task was not rendered easier from his habit of running his words together till his pen ran dry, and leaving most of the punctuation to the fancy of the reader.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

TO J. J. KAUP

CAMBRIDGE, July 22, 1865.

Your kind note of June has safely come to hand, and I can fully appreciate the difficulties of deciphering my chirography. I am never very distinct and when I have to scribble off so many letters as have been occasioned by father's departure, I can easily see that thin paper and my great hurry have caused you much unnecessary trouble. I hope you will not find this epistle quite so bad. I look forward with great pleasure to your invoice, and will now repeat some of my inquiries.

Do you wish for, 1, skins of some of our more common New England Mammalia? I think I could get together say ten or twelve species. 2. Any of our native New England Birds? I might send you perhaps some twenty or thirty species.

Our Entomologist (Uhler) has returned from Hayti, and I have this week set him to work to put aside for you North American Insects.

I am sorry to say that owing to father's absence, the Museum has not as many funds as I should like, so that I must use the greatest caution for the present in incurring any debts. Father was always accustomed to present to the Museum the result of his winter work in the way of Lectures, and this year having gone to Rio leaves us very poorly off, so that for the present I do not dare accept your proposition about the Lion. I hope, however, he will not remain on land too long and that he may yet in more favorable times find his way to the great Republic. We have very good news of father; the reception he has received in Brazil seems to have been a perfect ovation and facilities without number

Digitized by Google Original from UNIVERSITY OF MICHIGAN

have been placed at his disposal by the different railroad companies, stage lines and steamboats. He finds himself, therefore, so pleasantly placed near Rio, and enjoying so many facilities for transportation, that he has been tempted to remain much longer there than he intended, and has already accumulated considerable material. He has been quite successful in his investigations about Glaciers, and the geographical distribution of Fishes, the two main points of interest to him, and the prospects are at present that his absence will extend far beyond the time originally intended for his return. Our political affairs are little by little getting into shape and I hope we shall yet show to Europe that if we have been able to fight through a crisis which would have overturned any European Government, we shall pass through in safety the greatest political crisis and solve the great problem of universal liberty in a satisfactory manner.

TO J. J. KAUP

CAMBRIDGE, Sep. 12, 1865.

I have just received your letter of August 23d announcing departure of several boxes for us. As soon as I get everything which has accumulated during this vacation to rights, I shall make you an invoice of the things I had offered you and which I hope you will like. I wish I had received your note a few days earlier. I should have had the chance of securing for you a skin of a Bison. I shall, however, keep my eyes open and the next chance I get I shall remember you as well as the Bison. I hope before long to have duplicate skins of both Bison and Elk, as we have now no less than three parties at different places in the Rocky Mountains who have promised to do what they could for us

Digitized by Google Original from UNIVERSITY OF MICHIGAN

in the way of obtaining the skins of these larger animals. But you have no idea how hard it is to obtain them, the difficulty first of shooting them and next of transporting them such immense distances, no less than 1000 to 1500 miles often, through regions infested by Indians, making it a very hazardous experiment.

You ask me about Lyman. Now that the war is over he is back again at home, and as soon as he has put his private affairs in order, which have suffered from want of care during his absence, he will devote himself again to the same branch of the Museum as he has done before. We have still excellent news of father; he has just arrived at Para, and thus far his expedition has been as profitable to the Museum as he had expected. His health, as far as I could make out, is very much improved, and I hope on his return he will put his shoulders to the wheel and give the Museum such a start that we may come on the same level as the greatest Institutions of Europe. In the meantime I am not idle and do what I can. We have just published two numbers of our illustrated catalogue, one of the Ophiurans by Lyman, and one of the North American Acalephs by me, which I shall send you either by the next invoice or by the Smithsonian during this winter. I enclose also, as I had promised, a bill of exchange to your order for £3–5 shillings for the packing of the casts, which I hope will arrive in good order, and all I ask of you is to have patience with me if my invoices do not come as fast as I promised them, as it is simply incapability which will delay me and nothing more.

Agassiz had established relations with several hunters in the West, but collecting specimens there was then

Digitized by Google Original from UNIVERSITY OF MICHIGAN

no mere holiday matter, as shown by the following extract from a letter to a colleague contemplating a little trip to those regions: —

"The Indians are not at peace, and it is *death* to any small party in the present state of Indian warfare to attempt such a thing. I will give you an example: Two years ago an expedition was fitted out by the Government (5000 men) to drive away the Indians from that very region. The General in command offered me all sorts of assistance to transport collections (six wagons of four horses) if I would join him. Father's ill health made it impossible for me to leave Cambridge, but the General said he would get all the fossils he could and devote that amount of transportation to it. I of course expected great things, and on the return of the expedition he wrote me that it was out of the question to allow small parties of twenty or thirty men even to go away from the main body, and that he had lost on one occasion almost the whole of a collecting party, and that he could not allow others to wander off again. So I got nothing and probably would have left my own bones there to be picked up by some future Geologist and described as the ancient man of Nebraska. Several doctors accompanying army trains while passing through these regions have lost their lives; and we must wait patiently till the Indians are driven further West to undertake such an expedition. This is going on at such a rapid rate that I hope in the course of a few years to go there and pass a summer and thus accomplish one of my pet plans, which has been to do just what you suggest."

Digitized by Google Original from UNIVERSITY OF MICHIGAN

TO A. MILNE EDWARDS[1]

NAHANT, July 27, 1865.

CHER MONSIEUR:[2] —

I have received your kind letter of July 6 and also the diploma of the Philomatique Society; kindly thank the members of the society for the honor they have done me in making me one of them. I also thank you for your kind appreciation of my memoir on Echinoderms. I hope some day to pay a visit to the old world and make the acquaintance of all those that I know only by correspondence.

Before the departure of the steamer from New York, one of the birds, the Lophodytes cucullatus, was already among the dead. The heat in June has been intense and I much fear that the last invoice will not amount to much. Among the animals which we intended for you which have been sent us since, the mortality has been very great, and they simply suffocated with the heat. I lost in this way a young Caribou, two young Lynx — several different kinds of our indigenous birds, but I hope that by the steamer of the 28th of next month I shall be able to send you something. A Lutra Canadensis and a Mustela pennanti died on their way from Maine, as well as some small mammals. I pass my vacation at the sea-shore, and as soon as I get back to Cambridge I will see if I can send you an invoice of Crustacea from the West Coast of America. Stimpson, who used to have charge of our Crustacea, is at present in Chicago, where he has replaced a young man who is

[1] Of the Jardin des Plantes, Paris; on the death of his father he became its director.

[2] Agassiz's letters to his Paris correspondents are written in French, those to his German colleagues were usually in English.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

at present traveling on the frontier for the Smithsonian, and I don't quite know when we shall get him back. It seems to me that I remember that when he first began to work here he sent you a small box with a few specimens from California, and I will examine our books to see if I can send you any new species. Unfortunately I am only superficially acquainted with the Crustacea, and I fear I shall make a mess of it, but I will do my best. I have written to my father to send home alive what animals he could, and as they are accustomed to being broiled I trust they will be obliging enough not to turn up their toes before they arrive.

Kindly present my regards to your father.

TO SIR JAMES HECTOR[1]

CAMBRIDGE, Oct. 19, 1865.

Professor Agassiz intended before his departure for Brazil to have written you on the subject of entering into correspondence with you for the sake of obtaining fossils from New Zealand, which we are very desirous of acquiring. We can offer you in return North American Palæozoic things, or specimens of almost any other nature which might be perhaps acceptable for your studies. Our Museum is still in its infancy but we hope that one of these days it will have a national importance in this country and become the centre for the study of Natural History. We are particularly desirous of obtaining authentic specimens from the hands of original investigators and hope in this way to transfer little by little much of the scientific tradition of Europe and other countries to North America. The want of such

[1] Sir James Hector (1834–1907) did much to develop the fauna of New Zealand.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

traditional knowledge has been a great impediment in the development of Natural Sciences in this country and we hope to remedy this as far as lies in our power by entering into correspondence with all special workers over the whole surface of the globe. It is for this object that we ask your coöperation and we shall be most happy to hear of your wishes and satisfy them as far as it is in the power of our Institution.

During the years 1860–66, although busy with the affairs of the Museum, Agassiz contrived to find time for an immense amount of original work, and laid the foundation of all his purely zoölogical investigations. Before his trip to the Pacific he had been interested in entomology, and had devoted some time to the study of Lepidoptera. It is curious that the first publication [1] of one who was to spend his scientific life in the study of marine organisms and the questions arising from the examination of coral reefs, should have been on the mechanical principles involved in the flight of certain insects.

His summers, broken only by occasional scientific excursions to other portions of the New England coast, were devoted to research at Nahant. Here Mr. Cary had given a cottage to his daughters, Mrs. Felton and Mrs. Louis Agassiz; this they shared with Alexander Agassiz and his young wife. On a cliff overlooking the sea, low and vine-covered, with a rustic porch supported by unstripped fir logs, it was in the last degree picturesque, but must have afforded scant elbow-room for three families. In a rambling shed below the house, Agassiz and his

[1] "Mechanism of the flight of Lepidoptera," *Proc. Boston Soc. Nat. Hist.*, vol. VI, 1859.

Digitized by Google Original from UNIVERSITY OF MICHIGAN



Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN



Alexander Agassiz
about 1860

U of M

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

father fitted tables, shelves, and the necessary glassware for a marine laboratory; and here they set up their microscopes. In a bight near by, Alexander kept a dory which he used for collecting specimens. One of his step-cousins, then a small boy, used in after years to tell how he crept out to watch Agassiz skillfully launch his heavy boat through the surf and admire the ease with which, without apparent effort, he ran it up the steep beach.

The material for his studies was furnished by such animals as he could pick up among the rocks at low tide or catch with a scoop net from his dory, varied by an occasional find brought in by some friendly fisherman.

Among his best known publications of this period was a series of papers on the embryology of our common sea-urchins and starfishes (Echinoderms) which are found everywhere along our New England coast hidden in crevices of the rocks or among the seaweed. Until Johannes Müller discovered where to find the young of these animals, who would have thought of looking for them among the minute transparent and phosphorescent organisms that float near the surface of the ocean, and transform the wake of one's boat on a still dark summer night into a path of fire, and turn each dip of the oar blade into a swirl of molten gold?

Derbès and Krohn had studied the development of eggs taken from adult animals and artificially fertilized.[1] Müller had himself studied the later forms of the larvæ when they take on strange shapes with queer arm-like appendages, utterly unlike the starfishes and sea-urchins which they finally become. It remained for Agassiz to make a complete study of the embryology of these ani-

[1] This was a true fertilization, and should not be confused with recent experiments in stimulating various eggs by means of different salts.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

mals, partly by artificial fertilization and partly by collecting the tiny animals with a dip net. Müller had observed the young starfishes and sea-urchins forming at the lower end of the larvæ, but had supposed that they were thrown off by a sort of budding process common in some other Radiates, leaving the larvæ to maintain a separate existence. Agassiz was able to show that these Echinoderms first started as two separate growths on the surface of the tiny water tubes on each side of the stomach, called by Müller the "Problematical Bodies," and that these two growths finally enclosed the stomach and absorbed the whole of the larva, none of which was cast off. The eggs of such animals are excessively minute, and the whole development is on so small a scale that it can be watched only by the most skillful and painstaking study with the microscope.

During the course of these investigations, Agassiz noticed that at least one function of the curious little growths, known as pedicellariæ, lying between the spines of sea-urchins, is to clean the animal from impurities, which they pass along from one little arm to the next till the refuse drops off on the under side of the body. He was also able to declare that what had been considered several distinct species of starfishes were in reality distinct stages in the development of our common starfish; and he called attention to the fact that the embryology of Echinoderms is greatly modified in the so-called viviparous species. The publication of the results of these researches, illustrated by the most delicate drawings from his own pencil, drew the attention of the scientific world to the rising young naturalist.

It had been found by O. F. Müller and others that some of the higher forms of marine worms, which re-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

produced themselves by division, threw off sexual offspring; this was suspected to be a case of so-called alternate generations. Agassiz was able to complete the cycle by tracing the growth of the original unsexual parent stock from the eggs of the second generation. During these investigations he discovered that certain species, which had hitherto been considered distinct, were in reality the male and female of the second generation.

The first publication in the memoirs of the Museum was a study of the Ophiurans by Theodore Lyman. The second was a catalogue of North American Acalephæ by Agassiz, published in 1865. This volume was illustrated with three hundred and sixty figures drawn from life by his own hand. It is one of the longest and most important of his early publications, and contains many descriptions of jelly-fish first discovered by him both on the Atlantic and the Pacific. As a tribute to his zeal and efficiency as a collector and investigator, it may be mentioned that many of the Medusæ, which he collected on the New England coast fifty years ago, have not been recorded since.

Agassiz, among other things, showed at this period that Cape Cod was the dividing line for many species of the marine animals frequenting the coast of the North Atlantic, and he also did much work on Echini, in preparation of his "Revision," published several years later. Most of the work of these earlier years was so fundamental in character that it is freely quoted, consciously or unconsciously, in all modern text-books of zoölogy.

It will be remembered that Darwin's "Origin of Species" appeared in 1859. Although Agassiz never

Digitized by Google Original from UNIVERSITY OF MICHIGAN

joined in the turbulent discussion that followed its publication, his father entered the arena and remained a firm opponent of Darwin to the end of his life. Of Alexander Agassiz's final attitude on evolution, something will be said in a later chapter. The two following letters to a well-known German naturalist who, for political reasons, was living in Brazil, are interesting as showing what were his early opinions on the subject: —

TO FRITZ MÜLLER

CAMBRIDGE, Jan. 17, 1864.

Your very interesting letter of Sept. 9, 1863, has been lying before me for nearly two months. I have been obliged to delay answering so long because the friend to whom I had given the books for you in charge had not returned from an expedition to the western part of the Continent.

Nothing will give me greater pleasure than to answer your questions about the Cœlenterata and Darwin. It is only by discussing these broad questions in the most unprejudiced manner that we may hope to arrive at the truth, and mere dogmatic expressions of opinion ought never to influence us in the least, no matter what the source from which they come, and how great the authority may be. I trust that henceforth in Natural History, workers will not allow themselves to be biased by any weight of authority, either on one side or the other, but will examine the facts and carefully analyze them to see what they mean. We should not have so many wild theories in our science, did not every one who has studied a subject somewhat give generally such disproportionate importance to the particular part which they

Digitized by Google Original from UNIVERSITY OF MICHIGAN

have examined. [Here follows a technical discussion of Cœlenterata.]

With regard to the Darwinian theory, it seems to me to be only bringing up the same arguments as those used by Lamarck, only backed up by greater research and greater knowledge. The same objections which were fatal to the Lamarckian theory, and which ultimately caused it to disappear from science, till it was brought to life again by Darwin, will in due time cause the death of his theories; but good his scrutiny has undoubtedly done, as it is always a salutary thing for science to have a skillful skeptic attack its most religiously received dogmas. Far from having been drawn to the Darwinian Theory, all my studies and all my experience thus far has led me in the opposite direction. Embryology must be my support. Why should there not be nowadays going on what Darwin urges has taken place formerly? Does a crab ever lay eggs from which anything but something identical with it (the crab) does come forth? Does a starfish ever lay eggs from which an Ophiuran is developed? Darwin must show greater changes to have taken place than those of domestication, if he wishes us to hold to his theory with any sort of adherence. The idea that a plan pervades the animal kingdom must first be disproved and, what is by far more important, he ought to be able to show in the geological record the traces of all these changes. I only ask for the traces of those changes. But far from this he makes a sweeping assertion of the imperfection of the geological record and expects us to take that for the truth. Let him take any of the well-studied beds of England, as the Jurassic Period, or of Switzerland as the Molasse, or of this continent as the Silurian and

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Devonian, in all of which not a link is wanting, and let him then see what he can say about the imperfection of the record and the gradual transformation of one species into another.

What will be the first damning point and the one which will be the most readily seen and understood by people will be that of the geographical distribution of the different species of animals of the surface of the earth. The magnificent collection of Echinoderms of our Museum has been arranged with reference to this geographical distribution, and it has brought out many striking features totally unexpected. As soon as we have the maps made out I shall take great pleasure in forwarding them to you. If there is *anything* in geographical distribution, there is *nothing* in Darwin, and vice versa. The one flatly contradicts the other. But have we arrived at a stage in our knowledge where we can thus theorize about the *origin of species?* We know so little of the development, history, and geographical conditions of our most common animals that it will be in vain for us to philosophize without something to build upon.

The principle of the coincidence of geological succession and of embryonic development, as well as of complication (of structure), is by far a more suggestive one than Darwin's theory, and when once on that track will lead to more new views and ideas than was at first expected. Let us wait patiently till we know something more of the development and physical laws which affect the animals now living before venturing on such a dark subject. And as for me I am willing to be carried on by the current of my investigations, whithersoever they may lead, and to be satisfied with no theory, no wonderful panaceas, until I can see something more substantial

Digitized by Google Original from UNIVERSITY OF MICHIGAN

to uphold them than I can discern at present in the Darwinian Theory.

Agassiz in a later letter to Müller, continues the subject: —

"I see and grant fully the objections you may make to mathematical demonstrations as applied to organisms, and we must always remember that in one case we deal with simple formulæ, in the other with organic products, and here will always be the gulf separating the two. If the Darwinian theory is the correct interpretation of nature, you will be led naturally to the producing of organic out of the inorganic, working during an infinite time and through infinite forms. I do not see any escape from a logical sequence of Darwin's principles, for if you stop halfway and acknowledge a few primordial forces, or one force, you are on no sounder or stronger basis than the theorists who are always calling in the interference of the Deity. Call it in once and you must call it in always, and there is no more difficulty to imagine a single interference than many.

"I grant also the great force of your objections about the 'similarity of all eggs of all classes in their first stages,' but that has always seemed to me to be a very strong argument against Darwin rather than for him. If we can thus in a few weeks follow from eggs, laid by animals *of different classes*, apparently identical, such different results, but always the same as far as our experience goes, why has it never been given us to notice the converse, and see these eggs developing into *different classes* from the animals which laid them; and are we justified in taking the intermediate forms as the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

remnants and mementos of such transformations, rather than as independent creations? If we can ever represent organic forms by formulæ, I acknowledge that that formula should be capable of such transformation as to represent the organic in all its stages from the earliest time in the egg to its mature condition, by the introduction of the *proper variables*."

Digitized by Google Original from UNIVERSITY OF MICHIGAN

CHAPTER IV

1867–1868

THE CALUMET AND HECLA MINE

Agassiz had not been long established at the Museum before he realized that his salary would be entirely insufficient for the support of a family, to say nothing of his desire to possess the means to continue and publish his original work. Looking about for some remunerative employment, he obtained, through his friend Mr. J. M. Forbes, the presidency of some coal mines in Pennsylvania, a position for which his studies at the Scientific School had especially fitted him. Little is known of this episode; for a time in the early sixties, he appears to have managed the enterprise from Boston, with occasional visits to Pennsylvania, but seems finally to have realized that the occupation was not likely to prove advantageous. It is not clear how, with his duties at the Museum and his research, he managed to find time for this additional work.

This experience, though little in itself, must have disclosed his ability to handle men, and given him confidence. Without it, the owners of the Calumet and Hecla Mines might never have given him his chance, by turning to him as a forlorn hope when that venture seemed desperate.

The story of the discovery of the Calumet Mine, though based on apparently sufficient evidence, reads like a page of "Monte Cristo," rather than a forgotten

Digitized by Google Original from UNIVERSITY OF MICHIGAN

leaf from the early history of northern Michigan. The Keweenaw Peninsula, a celebrated copper region, juts out to the northeast from the south shore of Lake Superior. The copper-bearing strata run parallel to the coast and dip sharply to the northwest. The district is one of the very few places in the world where the metal is found in its native state, scattered through the rock in small particles, and less frequently in great tangled masses.

This region, then an unknown primeval forest, was ceded by the Chippeway Indians to the United States in 1843. The short excitement, a year or two later, following the discovery of copper, left the district still a wilderness, with here and there a small copper mine lost in the forest, and dependent on the little settlements of Hancock and Houghton at the base of the Peninsula.

Such was the condition in the early part of the second half of the last century, when a man named E. J. Hulbert was surveying a road in this wild country. One day, while walking about in the woods, he stumbled across a curious pit and, being an intelligent man, became interested in examining the hole. It appeared to be artificial; a huge hemlock standing on the refuse thrown up on the edge of the pit bore evidence of its extreme age. Clearing away the rubbish at the bottom, he found a very considerable quantity of verdigris.

This pit is now supposed to have been a prehistoric cache. On Isle Royal, an island opposite Keweenaw Peninsula, there are remains of ancient workings on copper veins. It is thought that the Indians, after mining there in the summer, would in the fall paddle to the Peninsula and cross it on their way south. A party of Indians, overtaken by an early winter, would have

Digitized by Google Original from UNIVERSITY OF MICHIGAN

chosen such a spot to cache their copper; for the location of the hole was such that the lay of the land would enable any one who knew of it to find it easily. We must imagine that any one of a hundred possible calamities overtook these primitive miners, who never returned for their treasure, which in the course of time weathered into verdigris.

This explanation did not occur to Hulbert at the time, who imagined he had discovered a spot where the Indians had once dug out copper. Looking about in the vicinity he found, a few hundred feet to the southwest, a huge block of conglomerate rock cemented together with particles of copper. From the appearance of this piece of rock, weighing many tons, he was convinced it was near its original position. He knew something of the formation of the country, and concluded he was close to a stratum of copper-bearing rock. After removing several dozen barrels of verdigris from the pit, he was surprised to find no further traces of copper. It was not till he had blasted a few feet below its bed that he uncovered a lode of copper-bearing red conglomerate, similar to the great piece of rock to the southwest. By the merest coincidence *the pit happened to be just over what later proved to be a great lode of copper rock*, afterwards known as the Calumet conglomerate. Improbable as this seems, Mr. Hulbert was always very definite in his statements that he did not discover the conglomerate until he had blasted below the bottom of the hole.

Hulbert was unable to get possession of the land on which the pit was situated, but he gained control of the land to the north. Assuming that the boulder was near the lode, and a line from it to the pit would give the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

approximate position of the outcrop, he extended this line to the nearest point on his own land, sank a shaft there, and again ran into the copper-bearing conglomerate. Firmly convinced that he had discovered a large deposit of copper, he went, toward the close of the Civil War, to Boston, which was already the financial centre for Lake Superior mines, where he met Agassiz's brother-in-law, Mr. Quincy A. Shaw, who was already interested in mines in that region.

Hulbert persuaded Mr. Shaw and his friends to purchase a controlling interest and further options in his scheme, known as the Calumet Mine. Later, when it became time to take up these options, Hulbert preferred to exchange his Calumet holding for securities of the Huron Mine.[1] This afterwards went to pieces, nearly taking Mr. Shaw with it, at a time when Calumet was most in need of funds. A few years later, as Calumet was becoming prosperous, Mr. Shaw made a new settlement with Hulbert, practically giving him one thousand shares of Calumet. This fortune Hulbert threw away in wild-cat speculations. The remaining years of his life were, however, passed in ease and comfort, thanks to an unusual generosity; for Mr. Shaw, realizing that the Fates had not been overkind to Hulbert, pensioned him handsomely.

It was arranged that Messrs. Shaw and Hulbert should take the mine on a lease, and the latter went back to Calumet to develop the property. The rock that was first found was exceedingly rich, and Hulbert, seeing such great masses of copper tangled in their bed of conglomerate, appears to have lost his head. He proceeded to quarry out the rock haphazardly, and buying a hun-

[1] A mine to the south of Hancock, in which Mr. Shaw was interested.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

dred teams of horses began to haul it thirteen miles to Hancock.

In the summer of 1866, after his father's return from Brazil, Agassiz took a vacation from the management of the Museum, and went up to Michigan to see the new mine. The so-called Calumet conglomerate, a stratum of felsitic porphyry, about twelve to fourteen [1] feet wide, carrying native copper, dips to the northwest at an angle of about thirty-seven degrees. The formation thereabout is singularly uniform, so that Agassiz was able to obtain some idea of the possible extent of the lode. He was so much impressed by its probable richness that during his visit, Mr. Shaw and a party of Boston gentlemen bought the land to the south of the Calumet Mine, on which the old Indian pit was situated, and organized the Hecla Mining Company. It must have been about this time that Agassiz succeeded in borrowing a comparatively small sum of money with which he secured the interest in these properties that formed the basis of his fortune.

On his return, he was made the treasurer of both companies. Toward the end of the year matters did not look so promising. Hecla was still in the first stages of development, but it was evident that Hulbert was not making Calumet pay. Consequently the company decided to operate Calumet themselves, and close the lease under which Hulbert had held practically complete control at the mine. When the working of the mine was reorganized on this new basis, Agassiz again went to Michigan late in December, 1866, stayed there about a month, saw a new man, Davis, put in charge of Calumet, and once more looked over the ground.

[1] In the lowest levels it widens out to nearly thirty feet.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Shortly after his return to Boston, he wrote the following letter to Major Henry L. Higginson, who, having married Agassiz's sister Ida, had bought, at the termination of the Civil War, a plantation in the South, and was trying to raise cotton under the chaotic conditions that prevailed there at the time.

TO H. L. HIGGINSON

CAMBRIDGE, February 3, 1867.

[The first part of the letter deals with some plantation matters.] Now about mining stocks, I really don't know what to say. I have perfect faith myself in the value of both Calumet and Hecla, the adjacent piece of land to Calumet which was purchased last year while I was at Lake Superior, and the *results* thus far obtained are beyond our most sanguine expectations. Calumet after this month will earn about $400,000 at least calculation till the end of this year, but we must out of this equip the mine thoroughly, build a good many roads, so that the expenses of this year together with the amount which must be kept in Treasury for work during the winter, when no copper can be sold, as it cannot be brought to market, will not leave much more than enough to pay from $5 to perhaps $10 a share in January, but the prospects of the mine (Calumet), from the amount of copper now exposed, are most magnificent and in the course of the second year, 1868, the mine will pay at least $15 a share and may go as high as from $30 to $40. Of course I will not conceal that all this depends upon the management at the Lake. The value of the mines, both Hecla and Calumet, are beyond the wildest dreams of copper men, but with the kind of management many of the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

mines have had, then even if the pits were full of gold, it would be of no use. This will of course necessitate careful looking after here, and I shall do all I can and all I know to put things on a good basis. In the present condition of Calumet, it is capable of producing copper at exactly one-third the price at which the most successful mines have ever been able to work.

Hecla is also controlled by Quin and Shaw family; it was only commenced last October, being a wilderness in September when I was at the Lake, and now it is opened enough to be able to get out nearly as much copper as any mine on Lake Superior, except Calumet, at a very small cost. I am sorry to say, however, that the price of the stock is pretty well up. Hecla is selling for about $50 per share and Calumet for about $75. The relative position of the two is about this; during 1867 Calumet will produce 12–1500 tons of ingot copper = $600,000–$750,000, at a cost of about $200,000–$250,000, outside $300,000. While Hecla will produce from 800–900 tons = $400,000–$450,000, at a cost of $180,000–$200,000. Now all the figures I give you are based upon the *present state of the mines*, always supposing that there are no additional facilities brought to bear during any part of the coming year, which of course makes all my estimates fall very far short of what we expect. One source also which will increase our yield is that as we go down in depth the bed increases in richness, and an increase of from 1–5 per cent for our rock is enough to make a difference of $500–$2500 a day, so you see what a margin there is. All my calculations are made also upon a yield of 10 per cent while thus far

Digitized by Google Original from UNIVERSITY OF MICHIGAN

nothing has been less than 15 per cent by our present processes.[1]

I will see your father in the course of a day or two and tell him all I can about this, but although I have put every cent of mine into these two mines, and have no temptation to sell out at the present prices, I hate to advise anybody about such precarious things as mines. One thing you may be sure of that when there is any screw loose I will be sure to let you know in time. I do not think I shall be able to build this year, first, because I have not the heart to sell out enough stock to pay for the house, second because I think it probable that I shall be at Lake Superior so often and so long that a house would be only an incumbrance, while I know if I have to postpone a year or more I shall not have to pay so much. I have the land, a very nice piece, and it will keep.

Modest as this prophecy was compared to the ultimate success of the enterprise, it seems singular that Agassiz should have been so optimistic at this time, for only shortly afterwards the mines found themselves in serious trouble. The hard, heavy, and tenacious conglomerate was a very different thing to mine and mill from the comparatively soft and less finely subdivided amygdaloid rock hitherto mined in these parts; the best mining men of the day declared that it could not be done at a profit. It was discovered that Hulbert had grossly misrepresented the true condition of affairs as they actually stood at Calumet, and the venture threatened to end disastrously for all concerned.

[1] The original estimate of the *average* percentage of copper in the rock was much exaggerated.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

At this crisis, the management decided to send Agassiz to Michigan to take charge, for he felt convinced that this rich deposit of copper could be worked at a profit, and that he could do it. Just before he left for Calumet, Charles W. Eliot, then an unknown young professor in the Massachusetts Institute of Technology, met him in the streets of Boston.

He said: "Eliot, I am going to Michigan for some years as superintendent of the Calumet and Hecla Mines. I want to make money; it is impossible to be a productive naturalist in this country without money. I am going to get some money if I can and then I will be a naturalist. If I succeed, I can then get my own papers and drawings printed and help my father at the Museum."

Seldom, indeed, have the aspirations of youth proved in such harmony with the achievements of maturity.

Before entering into Agassiz's life at Calumet, a few words may not be out of place here, for the benefit of those unfamiliar with copper mining. From the character of the deposits on the Peninsula, the processes used in extracting the metal from the rock are somewhat different from those employed where the copper occurs in the form of an ore, or chemical compound.

When the rock is brought to the surface, it first goes to a rock house, where it passes through a series of breakers, and is broken into small pieces. From here it goes to a mill, where it is reduced to little particles, after which the whole, flooded with water, passes over a series of washing machines and other contrivances, where the copper is drawn off, the refuse going out with the water. The whole process depends on the principle that by agitating the mass the copper will sink to the

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

bottom, and the lighter, non-copper-bearing particles will stay on top. There are three principal methods by which this pulverization at the mill may be accomplished; by a series of rollers, by batteries of small stamps, or by great heavy stamp heads.

Agassiz reached Calumet early in March, and at once found himself confronted with a multitude of difficulties which taxed his strength and ability almost to the breaking point. In order fully to appreciate the difficulty of accomplishing what he succeeded in doing while at Calumet, one must realize that the Keweenaw Peninsula was then more inaccessible in summer than Alaska is to-day, while during the long severe winters it was practically cut off from the rest of the world. For Green Bay was the terminus of the railroad, from whence it was a long and trying sleigh-ride of many days to Calumet.

Some extracts from an official report on the Calumet Mine, written soon after his arrival, may give an idea of the conditions there: —

"When it was decided to give the lessees notice that their lease would terminate on January 1, 1867, an assessment was levied to carry on a certain amount of Company work, such as buildings and fitting up necessary machinery to proceed at once with work on taking possession and have no delays. It was understood at that time that the lessees were to make an open quarry above water level, at a point commencing about 1600 feet north of the south boundary of the property. This plan was carried out unfortunately only just far enough not to obtain any receipts from the quarry, and in such a way as to compel very expensive running to protect the mine and render it safe hereafter besides subjecting

Digitized by Google Original from UNIVERSITY OF MICHIGAN

the works to be flooded with water. The original plan was entirely lost sight of and huge open pits were sunk in the middle of the lode. No attempt was made to support the roof, timbering was entirely neglected, and the mine was strained to its utmost capacity to produce rock at any price and regardless of the consequence.

"During the time this method of mining was progressing the most flattering reports of progress made were forwarded to Boston and the capacity of the quarry represented as fully equal to 100 tons well selected rock, while at the same time all provisions were making to secure the mine and go on with the regular openings independently of the quarry. The failure of the smelting works in reducing this selected rock and smelting it directly, compelled a change of programme, but only partial, as it has always been the intention to put on the location a small mill in order to treat cheaply our second quality of rock. For this purpose a small rolling mill was purchased, on the representations of the Agent of the full success of the Huron finishing mill, and his instructions were to put up this mill on its arrival on this location so that by the first of January it might be in running condition. Mr. Hulbert wrote over and over again that the mill would be running by that time, and only a few days previous to the visit of the Treasurer of the mine in December, such a letter was received.

"It was found on arrival at the mine that nothing had as yet been done towards erecting the mill except perhaps one week's work on the timber, and what was still more disastrous no preparation had been made for the connections of the different parts of the mine. Nothing was on hand to build a tramway for the mine and the mill. No attempt was made to pound a sufficient supply

Digitized by Google Original from UNIVERSITY OF MICHIGAN

of water, our dependence being placed entirely on a small beaver dam entirely outside of the limits of the Calumet property. A similar course was pursued with reference to the other mining supplies; almost nothing was supplied with the exception of hay and oats, so that during the whole winter up to the opening of navigation the mine will be dependent for its supplies upon Hancock and Houghton. After the failure of the smelting works, stamp mills were hired at (Hancock), and according to the figures sent by Mr. Hulbert to Boston, the mine could not have been earning less than from $25,000–$30,000 a month. These statements were, however, utterly false and the expenses actually incurred in December alone for producing ingot should have satisfied any one of the folly of attempting to go on and stamp our rock at mills 13 miles distant owing to the great cost of teaming, the want of all supplies at mine, and the uncertainties of the weather during winter.

"This suicidal course was, however, carried on in January and February, Mr. Hulbert concealing the true state of things and making estimates out of all proportions with what he must have known the expenses to be. This systematic deception was carried on not only with reference to the expense and results of the mine work, but in regard to everything else undertaken by the Calumet & Hecla Mining Companies in the way of general improvements. . . . The intention of the Company to make a tug channel through Torch River and connect Torch Lake[1] with Portage Lake was made use

[1] Torch Lake, to the southeast of Calumet, is a small body of water about six hundred and fifty feet lower than the location of the mines. From it a shallow stream led to Portage Lake which connects with Lake Superior.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

of to make a cut for a deep channel, which would have cost at least $75,000, the Company intending to spend about $10,000. Mr. Hulbert made no attempt to alter this contract in spite of numerous letters sent him to that effect, the contract being signed by him individually. Mr. Hulbert also, without making a careful examination of the country between the mine and Torch Lake, selected at the head of Torch Lake a site without troubling himself as to the feasibility of reaching the Lake by the shortest route.

"His strong recommendations of machinery were not found successful, inducing the Directors to run risks which, had the true state of things been represented, would never have been taken. This course of duplicity in Mr. Hulbert is the more inexcusable from the fact that he was a large shareholder, had received in everything the full support from the Directors, and it was with great reluctance that little by little they felt compelled to lose confidence and to question his actions. No Agent at Lake Superior ever had a more cordial support, and the value of the lode to be worked was such that a little common sense would with the expenditures thus far made have equipped this mine properly."

The Hecla Mine, being less far advanced, was not in so bad a condition, but the openings of the mine appear to have been made as stupidly as those on Calumet, and the property equally mismanaged. There are in existence a couple of old books full of the letters that Agassiz wrote to Mr. Shaw during this trying period. The pages, copied half a century ago, are faded, blurred, and often quite undecipherable; but from them we can gather something of the gallant fight of

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

these two brothers-in-law as they struggled to keep this desperate venture afloat. While Agassiz on his part was endeavoring, with insufficient means, to start everything afresh, surrounded by incompetent and dishonest superintendents who had been running the affairs of the mine to their own advantage, Mr. Shaw in Boston was confronted with equal, if not more trying, difficulties. The mines had already consumed more money than had been expected; Mr. Shaw's affairs were involved, he was at the end of his financial resources, pressed by his creditors, and loaded with law-suits. In the face of all this, he was straining every nerve to get money to develop the properties from a community that had lost confidence in them. As Agassiz wrote long afterward, "If Quin had ever known when he was beaten we should never have pulled the thing off."

One of the most difficult of the undertakings which confronted Agassiz was the necessity of changing the openings on both mines, so that in future the rock could be extracted by legitimate mining methods. Work was at once started to build a dam for the Calumet Mill. But as the stream was barely sufficient for this, he prepared to construct a small railroad to Torch Lake, which would not only open a mill-site for Hecla, but also furnish a convenient communication with the mines.

From the first, Agassiz mistrusted the advisability of setting up the rolls which Hulbert had bought for the Calumet Mill, as those at Huron were not working satisfactorily. Finding that he could buy on the Peninsula two heavy heads of Ball stamps, capable of turning out seventy-five to ninety tons of rock a day, he planned to set these up in the Calumet Mill. If later the rolls were proving satisfactory at Huron, he then proposed

Digitized by Google Original from UNIVERSITY OF MICHIGAN

to use his in the future Hecla Mill. Unfortunately, Hodge, the agent of the rolls, appeared upon the scene just as Agassiz was about to put this idea into operation, and persuaded him that with a few slight improvements everything would work satisfactorily. So the installation of the rolls in the Calumet Mill proceeded.

Shortly after his arrival, he found it necessary to discharge Hulbert's brother John, who was in charge of Hecla. Assuming the management himself, he kept Davis as his assistant in charge of Calumet. Hulbert, who was still a large stockholder, continued to give trouble.

TO Q. A. SHAW

April 19, 1867.

MY DEAR QUIN: —

E. J. Hulbert I find went to Boston fully determined, as I hear from quotations of his, to show Mr. Shaw what should be done; he was not going to have anybody here telling him what to do; either he (E. J.) or Agassiz would be master. That is the spirit and not the benefit of the Company. If anybody wants my place and can do better, let them have it; I am not anxious to stay here and be in a perpetual stew about a state of things which I did not inaugurate. One thing is perfectly clear: you cannot run either Calumet or Hecla without equipment as has been attempted, and if you attempt it and try any makeshifts to get out copper *except by regular mining, you will swamp them both*. The sum of the thing is, that we cannot stop and put things into shape; everything is out of joint here and it will take a great deal of money spent to apparently no purpose to get them on the right track again. All the shovelling of snow done here last winter could have opened the mine; days were

Digitized by Google Original from UNIVERSITY OF MICHIGAN

passed in cutting ice to get at foundations, and the extra cost of securing the large pits is at least $10,000 per month simply to keep them from falling in. *We* can only *spend more money* and get straight, and if we stop we are swamped. I know it is a hard road to travel, but I could see no other. We must raise money for Calumet and make that get Hecla out right. It is pretty hard to be in such a fix, but we must face the music, though I must say I get fearfully blue up here at times all by myself, and feel often like choking anybody who crosses my path.

Daylight is, I trust, coming; as soon as this old mill gets going we shall be O. K., moving ahead as fast as possible, but when anything is wanted must go to Houghton and now a trip is a thing of two days. Snow is going fast and I shall be glad of opening of navigation to get letters a little more regularly and quickly. I would give a great deal to have two days' talk with you about everything here.

Yours,

A. Ag.

A few days later he writes: —

"I wish you could manage to run up here for a few days. It would be worth a hundred pages of letters. You might bring Annie and Chicks up, for if I have to stay here till close of navigation without budging as things look now, I must try and arrange matters at the hotel to have them here till close of navigation. I think I can do it and it will not cost any more to live here than at home if they stay till November or end of October. I shall write Annie about it so that she may be ready to move at a moment's notice, but I don't want

Digitized by Google Original from UNIVERSITY OF MICHIGAN

her to run any risks and be up here if any serious stoppages are meditated; rather not see them till Xmas than run any such chances. I do not see how I can manage to get off even to go after them, and somebody must manage to send them up. I dare say father would like the trip and it might do him good. I can assure you it is fearfully lonely up here — not a soul to talk over and discuss matters with. I hate to saddle all on my back for fear of making any mistakes, and it takes such a time to write, and as time is too valuable to waste, we must jump faster than I like to do."

TO Q. A. SHAW

April 30, 1867.

It is frightful to have to spend so much money to get in order again. It would not have cost one-half the amount to have commenced properly; and had I not come when I did, Davis's orders from E. J. would have soon swelled cost sheets to 100,000 per month. March has been the capping of E. J.'s folly; all has seemed to accumulate in it, and I don't know what would have become of us had he gone on a couple of months longer. As it is, in Calumet we shall feel effects of it all summer, in [the] way of additional cost of timbering, filling excavation, and general inconvenience of working. It is enough to make anybody discouraged to see such waste, and as it is I don't see what we can do to save ourselves. We must assess again and both $5, or else we are gone. You will be out of funds after meeting April payments for March Cost Sheets, and it cannot be expected that Calumet mills can produce enough to meet all our liabilities which fortunately come due only in end of May, June, and July, but yet it will not give mills a sufficiently

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

long chance, and Hecla will certainly be left in lurch unless Calumet can pay back something, which seems improbable as she cannot save herself. You have now in your possession all papers necessary, Cost Sheets to April 1, Estimates of April and May, Product in Ingot total, and I cannot figure out of it except another $5 assessment on both, and where money is to come from God only knows.

I thought you had best be prepared for worst as soon as possible; we cannot escape out of this mess except to pay out continually, and if this infernal roller business don't swamp Calumet also, you may thank your stars. I feel perfectly frantic and so helpless, no tools to do anything, no machinery on which any dependence can be placed, nobody on ground or in country who has any idea what can be done with rollers and what is best way of running. The time, expense, fussing it takes to get Hodge's machinery in running order is fearful; nothing fits, and when all has to be sent to Hancock when anything is awry, it is an awful waste of time and money which no gold mine could afford. You can see yourself how it works. Nearly two months since I came, and we are no nearer our aim for Hecla than at first.

It seems hard after all our hopes to be brought to this pass; it is no use to try to figure out of it and attempt to whip the devil round the stump. We must have funds to go ahead, and if that cannot be obtained by assessments, why raise it on mortgage on Hecla and Calumet, say five years' time, and you are safe; but it is now a case of money or burst on both of them, and if it is burst the sooner we know it the better. I get perfectly furious here all alone, to be here entirely left to my wits and counsel, and at a distance of a month at

Digitized by Google Original from UNIVERSITY OF MICHIGAN

least before any answer can come to letters is more than I can stand. If it were a simple matter to go ahead, it would be a different thing, but to feel that a false step may swamp whole concern is not a pleasant predicament to be left in, and I trust never to be in such a shape again.

I do hope the mails will be a little more regular. I have nothing from you since April 11, and shall get nothing till the boats come up, of course just at the critical moment. I suppose there are about two weeks' letters lying in Houghton for you waiting for a boat. It is all very well for E. J. to rant about slow coaches; they are at least economical and don't throw money away by thousands as he has done, and lay out a plan which is carried out and means something, instead of this spasmodic jerking of money right and left without knowing the why or wherefore. I have never felt discouraged till now, but if Calumet mill works well we may yet get out of woods — otherwise the game is up, and we had best be prepared for it, as you seem to think it is impossible to assess in present state of feeling about copper.

Meanwhile the installment of the machinery in the Calumet Mill, on which all hopes of earning a little money to keep the mine working were centred, was nearly completed. But the tests were not satisfactory.

TO Q. A. SHAW

CALUMET, June 1, 1867.

We tried to-day mill with five tons rock, somewhat larger than what Rock House would give, so that our results will be somewhat inside of what we may expect,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

and I am sorry to say I am awfully disappointed. The utmost capacity of mill is three tons per hour and what is worse when running at that speed we make 20 per cent raff and that raff *we cannot finish* (it runs about 40 per cent copper); the rollers are too unequal to crush copper, inequalities in shells fully up to one fourth inch occur so frequently, and power is required to flatten out *so much* copper as is in raff so immense that rollers open or choke, and either make raff or clog. The copper cannot be got out before it gets to last roller, there is so much small stuff just big enough to open rollers and make raff, and when rollers do not open it falls through the inequalities.

So that the best that you can do at *mill* is 60 tons a day, and I doubt if that can be kept up day in and day out, of say 5 per cent ingot, 3 tons a day, 25 days, 75 tons ingot. Now add to that whatever barrel work will come out of Rock House, and what that will be no man can tell now. I am afraid I am figuring mill high. I *think* that Rock House will give us 50 tons barrel work at 60 per cent — 30 tons more ingot, total, 100 tons ingot — $46,000 at a cost of all included of $36,000, leaving not more than $10,000 a month. That is the best I can figure it at. Now this is altogether too small and will never do. Our mill is a hindrance to us.

Immediately after this distressing news, Mr. Shaw made a flying trip to Calumet, and the following plan was decided on. Two Ball stamp heads were ordered for the Calumet Mill. The work on the railroad was to be pushed ahead as fast as possible, a mill for Hecla, equipped with two Ball heads, and with a capacity for two more when needed, was to be built at Torch Lake.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

To meet these expenses assessments were levied on both Calumet and Hecla, which Mr. Shaw, on his return, managed to negotiate successfully.[1] In this he was much assisted by Mr. John Simpkins, of New York, who held a heavy interest in the mines and furnished very large funds for the enterprise at the time of its greatest financial depression.

In July, Mrs. Agassiz with her two children, one a very small boy and the other a baby barely a year old, joined her husband at Calumet. It was a rough primitive community with little to offer in the way of comfort beyond the bare necessities of life. The "hotel" was scarcely more than a log cabin on the edge of a primeval forest rising directly behind it. The cracks in the walls let in such a draft that the baby usually had to be kept in his crib; and whenever Mrs. Agassiz went out for a walk with her little boy she wore a revolver strapped to her waist.

In August Agassiz writes: —

"I have no time for any writing just now. I am driven to death starting mill at Lake and no place to put men on account of want of shelter. Shall get straightened out in a few days and will have a good man there to look after things. Railroad progressing and I feel very hopeful about it, though some days it seems as if all went awry. I have to be much of time trotting between Torch Lake and mine along railroad, which is not conducive to pleasant feeling in evening, and lately I have been pretty well used up, but am putting things through, and will give you account of progress of work at end of week."

[1] Mrs. Agassiz's brother, H. S. Russell, carried Agassiz's assessments.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Although a definite plan of action had at length been decided on, yet the work to be done exacted more ceaseless effort than ever. This included the supervision of both mines themselves, the perfecting of the Calumet Rock House, the changes in the Calumet Mill, the building of the Hecla Rock House, the erection of a mill at Torch Lake, and the construction, through a dense forest, of four and three-fifths miles of railroad with its connections to the various parts of the mines. It was, besides, necessary to do everything with the most rigid economy, while at the same time attempting to get a little product somehow to help construction expenses. All this was to be accomplished in a wilderness, utterly inaccessible to the outside world, so far as supplies were concerned, for at least half the year. In addition, Agassiz had no assistants on whom he placed any reliance, and was obliged to contend against the opposition of an entire community who regarded him as an interloper and outsider. His letters are full of these last difficulties.

"Keep up courage and never give up: we shall be all right yet. I get perfectly frantic with the men here: nobody who seems to take any interest in what is doing, all simply here to live on you, and when any attempt is made to prevent chances of slighting work, seem determined to put all possible obstacles in your way, and instead of attempting to help you, seem bound to see if they cannot compel you to yield and do as they want."

"The thing I drive and look after is the only thing that goes; and just as fast as I pass from one thing to another, just so fast do things move. I ought to have

Digitized by Google Original from UNIVERSITY OF MICHIGAN

had three good men, energetic and interested, at mine at head of incline, and at mill, instead of being compelled to do all I have to do myself. There is not a thing, down to seeing that cars get unloaded when they come here with materials, which I don't have to look after myself, and some days I am in utter despair. I don't wonder mines don't pay, for the people up here care very little whether they do or not as long as they keep going."

By the end of September the two Ball stamps were set up in the Calumet Mill, and a successful trial shed a ray of sunshine on the situation.

TO Q. A. SHAW

Sept. 25, 1867.

At last! Trial made this afternoon of one head successfully. Everything seems to be working well and I really believe we have made more copper in that time, we have run about one hour, than whole mill if running by rollers will. It is pleasant to see machinery go off from the start — no hitches, nothing out of the way, and by October 1 this head will be hammering away day and night and not stop again. About half the stockholders up here were out to see the machine start and mill was quite well filled. I am sure if they all felt as much relieved as your humble servant over its working well, they must have felt well. Now it remains to be seen what can be done by incline: I say 60–70 tons; all others say 75–85. We will say 65; that would give us at 5 per cent for 24 days per month, 144 tons ingot, say 150 tons ingot per month. I think we should live up to that. If we do, by January 1 we ought to

Digitized by Google Original from UNIVERSITY OF MICHIGAN

be out of the woods at Calumet and start the new year with a clean sheet. What a blessing it will be all round!

Railroad in Hecla is not progressing as well as it should. Emerson has rather let it slip and I have had to drum him up. We have had a most magnificent week thus far and nothing has been done except a little tinkering, while they ought to have been laying track these two days, and days now are precious. It is almost impossible to keep my eyes on all things. Railroad has not done as well since I paid attention to the stamp mill, but I trust now to give it a good start after fault-finding all round. At last the mill is moving at Lake. The first car of timbers for the foundation of the heads is in to-day and I trust to keep at it steady and get it done in about three weeks ready for the machinery. But then we shall have an interruption by raining, when nothing can be done till the stamp house frame is up and covered in. Indications up this way seem to point to an early winter. It looks now like November at home, and things still to be done before snow are appalling.

I shall do all I can, but one man is not enough. I ought to be at mill, on railroad, and at mine, and it is utterly out of the question to drive things together at same speed. Work at mine has progressed much better than anything else, with the exception of machine shop which has been waiting for shafting since September 1; and although it has been on way since 5th of September has not yet turned up. I expected to have done a good deal of work for stamp mill and rock house on it, and if it does not turn up, shall get some temporary shafting at end of week. If man who has contract for laying track does not come up to mark, I shall take things out of his hands. While laying track we shall be

Digitized by Google Original from UNIVERSITY OF MICHIGAN

at an expense of seventy-five men and four teams, or about $5000 per month, in addition to expenses of merely laying, $5000 being for furnishing wood for ties, handling iron and bringing up to tracklayers. It will take six weeks to lay track and get it in running order, I think (at least), from day we commence, under existing weather; this will make it November 15 before we have done. Late, very late, but cannot get through earlier.

TO Q. A. SHAW

CALUMET, Nov. 5, 1867.

I have just received an awful rap over the knuckles. The locomotive and track are not of one gauge; locomotive is *one inch too narrow*. This is perfectly infernal. First comes snow; and now, just as we had managed by dint of sweeping to lay a temporary track around the trestle of head of incline, to get locomotive up and push road to mine, we are brought to a dead standstill by this mistake and shall have to relay one rail whole distance from Lake and alter the axles of all our cars (which fit track admirably) to the new gauge. This is no fool's job and will, I am afraid, delay us greatly. I shall get, if possible, these changes made at Franklin or Pewabic shop; but I am afraid with all this work that it will fall on our machine shop and delay everything at least three weeks.

The fine weather is coming on again (at least I hope so as it has stopped snowing). Before we change the track I shall get forward all that is necessary to finish track as far as mine; and then, while they are laying that last 4500 feet, change the gauge of other part of railroad and bring up locomotive. I don't see that

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Weston is to blame: there are two ways of ordering, and from the method used here he had made a mistake in taking for the distance between his flanges the width of the track *inside* instead of outside the flanges, which makes a difference of just one inch. It is too exasperating to be blocked by such a blunder, and just at the last moment. All these things are never found out till everything is ready, and I am afraid we shall now be delayed in consequence. I go to Torch Lake early to-morrow and shall look at thing again after a night's sleep and see what can be done; and shall then at once go to Houghton and let you know what can be done there. Locomotive, I am afraid, cannot possibly be altered; and then the only remedy and cheapest thing is to relay one rail and change axles for all our cars. This letter is worse written than usual, but I am in such a rage that I cannot write better.

The long cold winter of the Upper Peninsula now set in with a suddenness and fierceness characteristic of that region. On December 7, Agassiz writes: —

"Have had no chance for writing: the bad weather has taken up all my time and could do nothing except attend to what little was going on. I was in hopes that my hard work was over; but I am just beginning to perceive that if this kind of weather continues, it has only commenced. In past eleven days hardly anything has been done and the fearful weather has brought everything to a standstill except what little could be done inside the stamp mills. The railroad is blocked entirely by snow and we cannot use locomotive till snow-plow is finished. All attempts to raise trestle work are useless, and men

Digitized by Google Original from UNIVERSITY OF MICHIGAN

cannot work outdoors in such a gale as has been blowing. Thermometer five below zero and regular hurricane most of the time, and about fifteen inches of snow and drifting badly.

"The winter has come upon us in good earnest and worse than any winter at Lake Superior ever commenced at this season. I trust it is not a forerunner of what one may expect for rest of winter; if so, we shall be fearfully behindhand with all new work, and I can hardly say anything as to the time when we may expect to commence operations on Hecla. We were getting on finely when tripped up in this fearful style; and I was calculating to have December at least to get some of the loose ends connected, and not have the regular winter snows and winds set in upon us before the new year, as is usually the case."

Two weeks later he writes:—

"We had hard rain yesterday which has played mischief with railroad and done more harm than two feet of snow. It froze hard after it and now whole track is covered with crust of about six inches of ice and we have by working all day only succeeded in going about one mile from mine. This was one thing that I had not figured on till spring and have been caught and snowplow is not properly rigged for it.

"I am getting so fearfully riled that I am afraid I shall do something foolish yet, if I am too much provoked. But I am bound to see this out and by next fall everything should be in such shape that I can leave; at least I hope so, for another winter here would be more than I bargained for and I hope by next October all will be running satisfactorily enough to let me pack up

Digitized by Google Original from UNIVERSITY OF MICHIGAN

my duds and simply make frequent visits, — but no use to look so far ahead. This is going to be a fearful winter for snow; there seems no end of it and no prospect of any alleviation till end of June. I get feeling pretty blue some days and should like to turn out whole lot of officers from beginning to end for their infernal shiftlessness and want of interest in anything except their own comfort. I hope to-morrow to manage and get through to incline with locomotive and finish bringing up freight which has accumulated there.

"It is impossible for me to keep on the way I have done. It is fortunate I am tough, for were I not I should have broken down; but I begin to feel the effect of this infernal work and drive; I get fearfully tired, a thing I have never known before, and I have had one or two pulls which warn me to be very careful. Neither you nor I anticipated what we have had to pass through when I left, but if we want to get any good out of it, the proper men to be trained by me now while I am here ought to be on the spot and the rough corners smoothed between different bosses and whole thing left in smooth running order by next fall. As far as I can see up here, I can only find two men, Buzzo and Hardie: the first, if he finds a thing equipped and a definite plan laid out, will work it out cheaply and implicitly follow instructions; Hardie has judgment and experience enough to make new work and carry it out and would be better man for Calumet and might act as adviser to Buzzo on Hecla."

Work on the Hecla Mill was progressing rapidly, and on February 7, 1868, he writes to Mr. Shaw: —

"Mill is now ready except connecting one head and belts of washing machines; and were drum at head of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

incline ready, I could commence stamping in twenty-four hours. The wood work is all out for that now and carpenters commence to put it together to-morrow, and to-day will, I trust, finish everything at head of incline and take rock down. But this infernal weather beats all my calculations — shovelling snow, shovelling snow — so that forenoon is spent in shovelling what snow fell during night and you get afternoon to work if the snow does not drive too hard."

The early tests of the mill did not come up to expectations, and in the middle of March he was utterly discouraged, and almost ready to abandon the enterprise.

"I am afraid we must consider Hecla a failure as far as equipment is concerned; it is not adequate for purpose and has just missed being what was needed by a little, which little will increase materially the cost of running and increase cost sheet considerably and thus lessen greatly the small profit we expected to make with two heads. I have done the best I could, but I am satisfied from the result that I have made many blunders and that much money has been spent which will not affect the purpose for which it was intended simply from my want of experience of the ways of men up here. I had been used before, when asking a man about things which he made his specialty, to get some reliable information and have based many of my blunders as it turns out on just such information, which is perfectly worthless, and all you can take here which is good for anything is actual working practice, which I have had no time from our peculiar position to study.

"We must look at things just as they are and not

Digitized by Google Original from UNIVERSITY OF MICHIGAN

attempt to gloss them over; and I must say, if they don't improve materially, my advice would be to sell out the whole thing in a block, if it can be done, and let somebody else try their hand at it. I have attempted, I think, to do the work with too small tools on account of expense, and am afraid we are attempting to dig a ditch with toothpicks."

However, when the mill got going smoothly, he found that it would stamp nearly two hundred tons a day, and his letters take a more cheerful tone; on April 13 he writes: —

"I will acknowledge that my letters of March 18–25 were very much of weathercock style; yet it was natural. I had worked like a horse and had taken all precautions I knew of to have things go off well from start; and to find on first handling how far below my expectations everything seemed to be was pretty hard and I knew everybody in district must have been only too glad to see me fail. I did not make sufficient allowance for things being new, railroad being a new thing up here, and I had expected everything to start off first pop as I had been accustomed to in coal mines where you do as well first day as afterwards; but then style of mine accounts for difference. They are now commencing to know their parts and everything is going along better, and capacity of different parts of equipment is not so far below my estimate. I also can see how to remedy and improve what we have."

But a few days later came a most discouraging accident: —

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

"We are having our share and more than our share of misfortunes, and this time we are stopped at Hecla for a fortnight at least. Knowing that you would expect me to get as much copper in April as I got in month ending a couple of days ago, I thought it safest to telegraph you of accident and tell you we should be idle the rest of the month at least. I telegraphed: 'Walls surrounding pit for additional heads at Hecla mill have settled from jarring. Shall be idle rest of month at least.'"

After the Hecla Mill was repaired, both mills at last ran smoothly. As the prospects brightened, Agassiz's letters become less frequent. He now had a man on whom he could rely as assistant, Mr. George Hardie, who had been persuaded to leave the Quincy Mine and work into the position of superintendent.

The Hulberts and other incompetent and dishonest individuals had been kindling jealousy and antagonism in a certain element in the community. The back waters from the Calumet dam flooded some land outside the companies' property; this the Hulberts took advantage of to make trouble, and the affair culminated in the cutting of the dam on the night of June 12.

"I telegraphed you to-day that Calumet dam had been cut and pond was empty. Ever since E. J. served his notice of a nuisance on us, we have had a watchman by day and night; but I am afraid they caught him napping. Last night was a very dark night and, being Saturday besides, a very good day, no one being busy at mill after 12 P.M. Towards 4 o'clock in the morning the watchman must either have been scared off or got

Digitized by Google Original from UNIVERSITY OF MICHIGAN

asleep, I don't know which yet; he ran up to mine at about 5, seeming out of his head, flung down his revolver and said the Irish had torn down the dam, and rushed off into town; so that no one knows how the thing took place. Hardie has sent for him and I hope we shall know more. We have had all men we could get on dam repairing damage and hope we can get the gap filled up again before 12 P.M., when they will undoubtedly serve an injunction on us to stop us from repairing the damage. If we can get it up, we are all right; if not, we shall have water enough, should it raise by rain, to run one head again by to-morrow night. John Hulbert is out of the way, having left about three days ago and confided his dirty work to a man by name of Burcher, who was his great man at election time.

"This is the worst pill we have had yet and I am afraid it is a case of assessment now for Calumet, unless we have plenty of rain at once, which is only thing that will save us. I wish I could just get my hands on John H. or E. J. I should shoot either of them with perfect satisfaction."

Fortunately the damage was temporarily repaired before an injunction could be served; the supply of water proved greater than was expected, and soon there was sufficient to run the mill regularly.

This appears to have been the last serious set-back that Agassiz had to contend with during his life at Calumet. The rest of the summer and early fall he spent in improving the organizations at the mines, strengthening the weak spots, and getting the whole to run smoothly. In August, Hecla produced about one hundred and eighty-five tons of ingot and Calumet

Digitized by Google Original from UNIVERSITY OF MICHIGAN

about one hundred and forty tons, each mill stamping over four thousand tons of rock during the month. Late in September conditions were such that Agassiz felt satisfied to leave Mr. Hardie in charge. The long strain was over and the fight successful, but at the cost, as it afterward proved, of the loss of his health.

It must have been with unutterable feelings of relief and satisfaction that he left the field of so many single-handed contests against what must have often appeared hopeless odds, and returned once again to the more congenial labors of the scholar, awaiting him at home. He reached Cambridge early in October, 1868, but always afterwards paid a visit to the mines in the spring and another in the fall, except on the rare occasions when he was prevented by illness or absence from the country. His travels and scientific expeditions were usually so timed as not to interfere with these semi-annual visits, and more than one voyage of exploration was postponed or abandoned owing to an unsatisfactory condition at the mine that required his personal attention.

On December 15, 1869, Hecla paid its first dividend of five dollars, and Calumet followed suit with a like amount on August 5, 1870, and after that neither company, nor the company into which they were consolidated, ever passed a dividend; or, with one exception, borrowed any money until in 1909 notes were issued in purchase of the stock of various other companies in this Lake Superior district.

In May, 1871, the Hecla Mine, the Calumet Mine, and the Portland and the Scott Mining Companies were consolidated into the Calumet and Hecla Mining Company, with a capital stock of one hundred thousand shares, Mr. Shaw serving as its first president. A few

Digitized by Google Original from UNIVERSITY OF MICHIGAN

months later he retired to the board of directors, and Agassiz was made president, a position which he held to the end of his life.

A detailed account of the development of the mine, from such comparatively modest beginnings to the gigantic enterprise that it afterward became, would swell the present volume beyond all reasonable proportions. Until a few years before Mr. Shaw's death in 1908, he and Agassiz directed the policy of the company, but as the former had no training as an engineer, the work of developing the mine itself fell to Agassiz. It was always his policy to keep the mine opened up well ahead of the work, — fifteen or twenty years ahead in later years, — and when it became certain that the lode contained a vast amount of profitable rock, he had the ability to see what the conditions would be years later, and make ready for them far in advance.

Such a policy naturally incurred great expense, for, to use his own words, he always spent a dollar and a half if he could see three dollars in the future. Most people, however, were not far-sighted enough to be able to see the three dollars, and there was no little criticism of the extravagant management of the mine, much of which came from the very men who had formerly declared that the lode could not be mined at a profit. For example, the installation in 1883 of the five thousand horse-power "Superior," a huge engine for those days, was thought at the time by many people a foolish proceeding. It was designed to hoist six skips, each with a capacity of four tons of rock, from a depth of four thousand feet, and also to run four Rand compressors. This was greatly in excess of the needs of the mine then, which was hoisting two and a half ton skips from an

Digitized by Google Original from UNIVERSITY OF MICHIGAN

average depth of about fifteen hundred feet. In 1911 this engine was hoisting seven and a half ton skips from a depth of six thousand feet! On one occasion he threw away, unused, without the slightest hesitation, some extremely expensive machinery, because while it was being made he had discovered a cheaper method, and realized that this action would prove far wiser in the end.

It was always his aim, wherever possible, to duplicate the machinery, "to guard stockholders against disasters incident to a mining company's work." The quotation from an annual report characteristically continues: "Nothing else could have insured our employees the steady work they have enjoyed since the opening of the mine. A more parsimonious policy would have entailed many delays."

Contrary to the general practice of the day, but backed by Mr. E. D. Leavitt, his mechanical engineer, he installed the most expensive hoisting engines in order to save fuel. At the time this was not generally thought the most economical method, on account of the irregularity of the work required of the engines. Only in very recent years have the best experts in mining machinery conceded that such engines justify their expense. This is but one of many examples where in economy and efficiency the methods employed have been in advance of the times.

In 1901, Mr. James MacNaughton, a product of the younger generation which had grown up at Calumet, was made general manager. This proved a most fortunate appointment, his executive ability, and power to handle men, enabling him to assume much that had formerly fallen on Agassiz's shoulders. A new generation also was growing up in the Boston office, where

Digitized by Google Original from UNIVERSITY OF MICHIGAN

another Quincy A. Shaw and Agassiz's youngest son, Rodolphe, were working into the management and relieving the president of many details.

By 1909 the mine had reached vast proportions; its lowest point was eight thousand feet on the lode, and the area of the territory that had been mined and opened up on the conglomerate lode could be measured in square miles, whose shafts and drifts must amount to fully two hundred miles of passages, from which about thirty-seven million tons of rock have been mined. While on an underlying amygdaloid lode, opened in later years, are many more miles of openings in what is practically a new mine which promises to rival in magnitude the old conglomerate lode. At the time of Agassiz's death, the company (exclusive of the subsidiary companies) employed an army of fifty-six hundred men, and was mining the vast amount of about ninety-three hundred tons a day! This is believed to be the largest amount of rock mined and treated by any mine up to that time. The product of refined copper for that year was 82,816,230 pounds. The scale of the equipment may be judged from the fact that *one* of the pumps at the mills[1] had a greater capacity than any in existence, until its designer, Mr. E. D. Leavitt, built a larger one for the pumping station of the Boston Sewerage Department. Since Hecla paid its first dividend in 1869, the company had paid to its stockholders, up to December 31, 1909, the huge sum of $110,550,000.

It is conceivable that a less far-sighted policy might possibly have enabled the company to have made even greater returns in the past. But Agassiz was building not only for future years, but for a future generation,

[1] The Calumet Mill was moved to Torch Lake in 1871.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

and less enlightened methods would never have enabled the company to handle so economically to-day such vast quantities of lower grade rock as it is hoisting from the deeper levels of the mine.

The spirit of broad humanity with which Agassiz cared for the welfare of some fifty thousand souls clustered about the mine deserves special notice. Ever mindful of the comfort and well-being of his employees, his genuine interest in the community and the intelligent measures he adopted for its prosperity resulted in a model settlement. The cordial relations he established between employer and employee might well serve as an object lesson, in these troubled times, of what may be accomplished when the workman is treated with understanding, sympathy, justice, and intelligent consideration.

Agassiz made it his personal interest to see that the men were well paid, well housed, and provided with the best of schools, libraries, hospitals, bath-houses, and churches. Above all, he established especial provision for a prompt and fair attention to all complaints.

Some years ago the Governor of Michigan, in speaking of the labor conditions in the state, said that there was one man who had done more than all others for humane and reasonable conditions of life among its working-people, — Alexander Agassiz.

We are accustomed to think of the man who devotes himself to pure science as aloof from the world, with but little interest or ability in the practical concerns of our complex modern civilization. Such is perhaps especially true of the biologist, whom we imagine immersed in his studies, surrounded by his specimens, and letting this globe spin on as it will. Agassiz is a striking excep-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

tion to whatever truth there may be in such a belief, for while engrossed in his scientific life, he at the same time produced a wonderful practical achievement.

Called as a last resort to prop up a falling enterprise, he transformed it into one of the most prosperous and extensive mines known in the history of industry. By the successful development of this property, he brought wealth to many people, and prosperity and happiness to thousands of workmen; while he himself was thus enabled to lead a series of scientific expeditions to the ends of the earth, any one of which would have more than fulfilled the fondest dreams of many a poor naturalist patiently bending over his microscope.

In the Calumet and Hecla Mine, he has left a remarkable proof of his very extraordinary executive ability and business foresight. That mine is a monument such as few men can show as the result of a life's work; when we consider that it was the by-product of the brain of a man whose life's interest was abstract science, the monument becomes unique.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

CHAPTER V

1869–1873

THE REVISION OF THE ECHINI

Not long after his return from Calumet, Agassiz and his small family settled for the first time in a home of their own, a little house on a side street in North Cambridge near Porter's Station, which combined the advantages of being cheap and not too far from the Museum. His first care was to reëstablish his scientific correspondence. As an example of the eagerness with which he threw himself into his former intellectual life, it may be mentioned that on November 8 he wrote seventeen scientific letters, all plainly attesting his hunger for science during the past two years of exile. One of the events that most excited his interest on his return, was the result of a dredging expedition the previous year of the little Coast Survey Steamer Corwin off the Florida coast. This opened up a new world to the marine zoölogist, and fired the imagination of the returning wanderer from the wilds of Michigan.

TO FRITZ MÜLLER

Cambridge, Nov. 8, 1868.

Your letter of March, 1867, father sent up to me to Lake Superior, where I was compelled by family affairs to go and spend nearly two years in order to extricate them from some unfortunate mining enterprises into which they had become involved. Thank Heaven I am

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

now done with copper mines, and have returned with all my heart to my studies, which I hope nothing will again interrupt. You can easily imagine my satisfaction at returning to my intellectual mode of life when I tell you that for the last one and one-half years I have not opened a single book on Natural History, and though the accumulation of books seems rather formidable just now, I shall hope soon to get through with the more special and important parts and find myself where I started from. I left some work unfinished for the Museum, my "Revision of the Echini," which I shall do as my share of Museum work, and hope to complete next year; and my own studies I shall go on with, the embryological work I left off, which seems to me to promise more satisfactory results than anything else. Since I have studied Annelids and especially the young, I begin to have very serious doubts concerning the existence of types. Radiates always seemed to me so well and naturally circumscribed, but the embryology of Echinoderms and of some of the Annelids certainly is pointing out coincidences and affinities which the study of the mature animals was far from showing. The larva, which you figure in your letter, is just one of those forms and like the forms of the Planariæ of Müller are probably all *Nematoid* larvæ, and seem to show a closer affinity between Echini and Annelids than we suspected. —— had indeed pointed this out, but simply theoretically. He, like many English, is very fond of generalizing other people's observations and passing them off as his own the moment he has written a *Review* of the subject, which is the curse of English science and scientific men.

I hope next summer to be again on the seashore

Digitized by Google Original from UNIVERSITY OF MICHIGAN

somewhere and gather the broken threads of my drawings. In meanwhile, if you have anything interesting in way of Echini, I wish you would send it to me. The Museum will soon publish a most valuable Palæonto-geological contribution in the next Illustrated Number of the catalogue, viz.: "The Deep Sea Fauna of the Gulf Stream between Florida and Cuba." Professor Peirce, the Superintendent of the Coast Survey, deputed last year one of his assistants, Pourtalès, to make dredgings there. His first results, of which you have undoubtedly received a copy, No. 6 Bull., M. C. Z., were so important that it was decided to send Pourtalès again this winter, and he goes again in a couple of weeks better equipped, and with the experience he has gained last year we may hope to obtain grand results. The Fauna living to a depth of 500 fathoms — 3000 feet — 100 atmospheres! is WONDERFULLY RICH IN EVERYTHING — Echinoderms, Corals, Ophiurans, Starfishes, Annelids, Crustacea, Mollusca, etc.; and as soon as he returns we will all set to work to work up his material, which cannot fail to be of the greatest importance. There is, among other things, a new family of *Pentacrinoida!* a most charming thing, and which, with the embryology of Antedon by Carpenter, will teach us much about Crinoids.

Since my return, the Museum has had a large accession to its means, given partly by the State and partly by private persons, of a sum no less than 150,000 dollars, which will enable us to double our room by building, and give us a chance to make our collections available for study. As far as I am concerned personally, the Museum is of very little use to me, as I believe in study ex natura, and have but little fancy for closet investi-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

gations where you get long Memoirs about animals which have never been seen living or in state of nature by the author.

In writing to Professor von Siebold, his old teacher of natural history in Freiburg, Agassiz says of the windfall to the Museum:—

"The whole of this is to be spent in three years, so that with our present means we shall be enabled to do a great deal towards arranging our large accumulated material. Our energies will be particularly concentrated on our Fish collection which, since the Brazilian accession, must now be the largest in existence, to judge at least from Günther's catalogues. I should say we had at least twice as many species on the average as the British Museum. We are increasing fast and, as far as Radiates and Mollusca are concerned, we must not be far behind any one. Our great deficiencies are in Birds and Mammals, which are things however more easily obtained than the rest."

While at Calumet, Agassiz's attention had been called to the habits of the beaver, and even in the midst of his arduous work there he managed to find time to study these interesting animals. But just as he was preparing an article on the subject he found himself forestalled.

TO LEWIS H. MORGAN

CAMBRIDGE, Dec. 14, 1868.

Having been a resident nearly two years of Calumet, on Keweenaw Peninsula, Lake Superior, I have had from the explorations I was making repeated opportunities to

Digitized by Google Original from UNIVERSITY OF MICHIGAN

examine a great many beaver dams, both deserted and still occupied. I collected a good many cuttings, chips, etc., made as many observations of habits, measurements of dams, canals, as my time would allow — just as I was preparing to get my notes together I found in the "Nation" a Review of your book on the beaver, and since my return to civilized regions it was one of the first things I read. As I wrote father, it had taken the wind out of my sails completely and there was no necessity of my doing anything further at present, as your experience and opportunities had been more ample than mine, and had evidently left, as far as I can judge from first examinations, but little and that of trifling importance, to add to the natural history of the beaver.

I have some observations as to the time which beavers have inhabited the regions which may be accurate enough to determine the length of life of this species in the district, but my data are not yet in shape. Having passed two winters up there, I find that the beavers are more active during that time than you give them credit for. This is not confined to periods of thawing, but during the regular winter weather. I find also that they *migrate in large numbers* during that time, and while walking on snowshoes through the woods have come upon their tracks in all directions *at considerable distances from their dams*. In two cases I have followed their trails and have come upon a pair of young beavers starting their dam in a fresh locality. The beavers I observed seemed much more shy than yours and the effect of interfering with their dams, even in a small degree, almost invariably resulted, if repeated two or three times, in driving them off. I was very desirous of obtaining photographs of some of their workings, but all my

Digitized by Google Original from UNIVERSITY OF MICHIGAN

attempts, with the best local talent, failed lamentably. Father tells me that he saw some of your original photographs of dams. Is it possible to obtain a copy of the Grass Lake Dam? I should like very much to possess some remembrance of them more tangible than my notes and collections. If you can help me in procuring a copy from your negatives, if still in your possession, I shall appreciate it greatly.

Not long after this, he published a short article corroborating Mr. Morgan's view, that the beaver did not live in nearly such large communities as was popularly supposed, and that the very considerable results of their labors should be attributed to time, rather than the number of individuals at work. From the depth of the deposits of peat above the beaver dams about Calumet, he estimated that several of these colonies must be at least nine hundred years old. Some of the beaver ponds there covered an area of forty acres, with beaver meadows about them of two hundred or three hundred acres cleared from the virgin forests. Where there were dams one behind another, these meadows sometimes covered a large portion of several sections of land.[1] In conversing with intelligent trappers of the Hudson's Bay Company he learned of places in Canada where the beaver had changed the character of very considerable portions of the country.

Besides his studies on the Pourtalès collections, he made, during the winter of 1868–69, considerable progress on his "Revision of the Echini;" but the pressure of overwork, anxiety, and hardships at Calumet had undermined his health, and his work was forced to be

[1] Six hundred and forty acres.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

intermittent. His lack of condition culminated in the spring in a very severe illness, from the effects of which he never in after life completely recovered. One day, when he was able to crawl about again, he chanced to meet his friend, Mr. James Lawrence, of Boston. Lawrence told Agassiz that he did not think he was looking at all well, and the latter replied that he thought he was dying.

"Nonsense," said Lawrence, "what you need is rest and a change of scene. Why don't you go to Europe?"

"I cannot afford it," answered Agassiz.

"Oh, yes! you can," said Lawrence; "I'll be your banker."

Agassiz always felt that he owed his life to this generosity of Mr. Lawrence, and never spoke of the event without emotion. Thus he was unexpectedly enabled to visit the museums of Europe, a long wished-for opportunity, necessary to complete his "Revision of the Echini." Examples of doubtful species were shipped abroad, in order to compare them directly with the original specimens in the various European museums. He sailed with his family in company with the Lawrences from Boston for Liverpool on the Liberia in September, 1869. Among the letters that he carried to the scientific friends of his father was one to Darwin, in which the elder Agassiz declared, "You will find Alex more ready to accept your views than I shall ever be."

During this first visit to Europe, Agassiz made the acquaintance of nearly every working naturalist in Great Britain, Scandinavia, Italy, Germany, and France. Everywhere he was received as the son of an old friend; thus it happened that his scientific friendships were mostly formed with men older than himself, and but few of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

them survived him. After leaving the children at Malvern, he took a short trip with his wife through Scotland, and then crossed to Belfast to visit Wyville Thomson, who had just returned from a dredging expedition on the Porcupine. Agassiz was naturally much interested in examining the collections brought back, and to learn that some specimens had been dredged from twenty-five hundred fathoms, an unheard-of depth in those days.

In writing to his father on October 19, he says: "Je suis ici chez Thomson qui est de première force et un individu qu'il faut soigner." Two pleasant visits to Lord Enniskillen and Sir Philip Egerton, old friends of his father's, closed the visit to Ireland.

He was in London from November 11 to December 3, living with his family in lodgings on Jermyn Street. While there he made the acquaintance of most of the scientific men of the day, including Lyell, Owen, Hooker, Lubbock, Huxley, Wallace, and Darwin. The class discriminations in Great Britain seem to have much annoyed him; in one of his letters home he writes: "What a state of things for the 19th Century! If it strikes me here, what will it be on the continent! I cannot imagine how people with any common sense will submit to such caste distinctions and so much nonsense."

His days were spent in working at the British Museum, and sight-seeing with Mrs. Agassiz. In the evening, when he was not dining at one of the scientific societies, they would go to dinner with one of his new friends. From Mrs. Agassiz's journal we learn that one evening, after dining at the Philosophical Society, he went to the Royal Society, where he gave a short speech on the deep-sea dredging of Pourtalès, and then slipped off to McMillan's to have a chat with Tom Hughes over the

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

recent defeat of the Harvard crew by Oxford on the Thames.

Early in 1870 he was busily at work in the Paris museums, comparing Echini and arranging for exchanges with Cambridge. In one of his letters to his stepmother he writes:—

"It has been such hard work to do the little I wanted to do, for I have spent most of my time in palavers, etc., etc., and it took me sometimes three days to do a thing a couple of hours would have finished had not all the facilities been surrounded by so many keys and had I not been forced to wait for so many appointments of other people, which give them half an hour only, as they watch you the whole time like so many cats while you are working and don't trust you a moment out of their sight, which I should judge was absolutely necessary from the habits of some of the people who come to examine collections.

"The casts are the most difficult things to obtain here; they will not sell them, and will only exchange them on a principle I do not like, that is, you must pick out yourself all you want, pack it yourself and then at the other end of line do the same thing again. I had really to be almost impolite and tell them I could not receive things on those terms; otherwise my whole stay in Paris would simply have been a transfer of my Museum work from Cambridge to Paris, which I had no idea of doing; as it was I spent nearly three weeks going to the Jardin and École de Mines to do what would under ordinary circumstances have taken me at the outside four or five days, and which has made me swear I would have nothing more to do with any Museum during my stay here

Digitized by Google Original from UNIVERSITY OF MICHIGAN

if it had to be purchased at cost of spending all one's time there and doing all the work at both ends. I dare say if I had come here perfectly well and willing to work all the time I could have got a great many things which would be very valuable, but I must now *refuse everything* which is offered, as it all implies so much work that I cannot stand it.

"So you see that all I can do and all I intend to do, is simply to see what there is, what they can give, and *get out exchanges when I get back*; we may lose much, I dare say, which could be had on the spur of the moment, but the price for which it can be had I am not capable of offering, and I intend to have a good time and not work myself to death as I have done here in Paris."

The end of March found Agassiz and his family on their way to Switzerland; as they swung over the Jura he watched eagerly for the first glimpse of his native Alps, and his wondering little son saw his staid father transformed into a joyous boy as he excitedly pointed out the faint outline of the mountains climbing up in the southern sky. After a short visit to their Swiss relations, Mr. and Mrs. Agassiz started on an extended trip through Europe, leaving the children in charge of a great-aunt in Lausanne.

TO MRS. LOUIS AGASSIZ

FLORENCE, Apl. 30, 1870.

MY DEAR MA:—

Annie and I both found a letter from you at Florence, where we have had a most pleasant time; we met here most unexpectedly her Aunt Rose and Amelia and Mr.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

and Mrs. Upton, as well as Mr. Jonathan Russell who had joined them in Rome. We expect to go along with the Milton aunts as far as Vienna and perhaps to Munich, as they are traveling now quite rapidly, intending to get to Paris the last part of May. I have had a very interesting time in Northern Italy and am glad I have seen so much of it, and was very pleasantly surprised at the energy and intelligence displayed in the scientific establishments which seem to me far superior (not in means of course, but in spirit) to the French schools of similar character. At Bologna I missed Capellini. They are to have a Congress for Anthropology there in Bologna some time in October, on which occasion he is to play Grand Mogul.

At Florence, Mr. C—— showed me all there was to be seen, and we talked over what they could send us and what they wanted. He has already quite a lot of things almost ready which a Mr. de Ancona, a very pleasant assistant here, is putting up for us little by little. They have fine fossils from the Val d'Arno, mostly vertebrates, but unfortunately they are not in good enough condition to be cast, and they have mostly unique pieces collected a long while ago. They have a few casts which they will send us by and by, and plenty of Tertiary fossils, also some fine fishes and Tufa Lias and Cretaceous fossils specially, which are most wonderful as a fauna, resembling more our primary American Faunæ! Medina Sandstone, than anything else I know. This fauna is not yet worked up, but will be in course of time; a Marquis Strozzi is at work upon them now. There are some of the most puzzling marine foot-prints and impressions which I wonder what he will make out of them. I wish I had had time to go to Pisa and Leghorn, where since

Digitized by Google Original from UNIVERSITY OF MICHIGAN

the work of enlarging the harbor they have accumulated a good many fine things in the way of fossils, but I cannot do all this time and must leave it for another time. We may do something by letter with Meneghini when we are ready.

We went to dine at Mr. Marsh's, the American Minister here, who is a very bright and pleasant man and wishes to be remembered to father. They live very pleasantly in a villa out of town, some old palace built before the flood, but where they have introduced a furnace. We met some Americans there, a sister of Mrs. Strong of New York, Mrs. Goddard, and Miss Fearing, a still younger sister. The few days we have passed here have almost taken Annie's feet off; she has seen so much and read so much that I expect she will have to be carried to the cars when we leave. Sight-seeing with limited time is not worth much — it is too much like hard work and the fun is all in the recollection, when you have not seen too much to become perfectly idiotic at end of your day's work. I envy the Museums their old palaces; it gives them plenty of room, and there are so many Jesuit Palaces, ready to be confiscated, that with a little exertion any amount of room would be available. I wish we could transplant some of them to Cambridge; besides the good looks of the outside we might have plenty of room. The only Museums thus far I have seen which are not crowded are those of N. Italy; they seem to spread as much as they like and be sure of an ample supply. Thirty-seven rooms in Florence!! Forty in Bologna! only for Natural History! We were so glad to get such continued good accounts from father.

With love to all,

Yours, A. AG.

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

Wherever he went, the Museum was never out of his mind; a little later he writes: "What part of the Museum is going up? Nobody has said a word about it. I am very sorry I am not there to superintend the putting up. I think what I have seen might have been useful, but I hope it will not be too late as far as internal arrangements are concerned, and that we may still profit by what has been done."

TO MRS. LOUIS AGASSIZ

HAMBURG, June 6, 1870.

Your first letter from Deerfield came to Berlin the day we were leaving. We made but a flying visit there, still managed in the week we stayed to see a good deal. I spent most of my mornings at the Museum with Dr. Martens looking at the Sea-urchins he had described from Japan. I liked him extremely; he is a capital type of an Assistant, has *no* specialty and is interested in whatever turns up; and he manages to keep things in capital order. He knows a great deal too, and he is one of the few men I have seen thus far who have a general knowledge of Zoölogy. Peters also was very polite to me and I thought him very pleasant. I passed an evening at his home where we found Dove, who is an original, and a type of a German such as I had not seen before. He sent many kind messages to father, as does Peters and Ehrenberg, whom I saw for an hour at his house.

The Zoölogical collections of Berlin are excellent and in good order, and the Invertebrates as a whole, specially when taken in connection with those in the Anatomical Department, the best I have seen thus far. Reichert, who has charge of Müller's collection, is not very careful, and I am sorry to say that many of Müller's

Digitized by Google Original from UNIVERSITY OF MICHIGAN

things are going to the dogs. I did not see either Beyrich, Virchow, Duprey, or Reymond; they are all absent, it being holidays for the first week in June. The Palæontological collection is all in drawers and I had no time to examine it more carefully. Müller's type of Starfishes I would have examined, but it would have taken too long to do anything of use for the fifth Volume, and it will be much simpler to send them over and have them compared than to spend the time now. Dr. Hagen was daily expected but we left before he arrived. (I saw his friend —— in charge of the Entomological collection, who struck me exceedingly unpleasantly and looks just as he writes his yearly reports, as if he had a special grudge against everybody who did not agree with him.) I saw also by chance at Peters's, the writer of Decken's "Journey in Africa," who abused the Museum for not sending him *all* our collections from Zanzibar; I was quite amused at the awkwardness he felt while I was round.

I don't remember if I wrote you that I had succeeded at Munich in getting something you wish; we can get photographs printed like lithographs, so that when I return I shall make out the Plates for the "Revision of the Echini" from the photographs Sonrel is now making for me, and I think the whole can be done at very little above the price of printing with us. I am gathering material for this everywhere, and at Vienna, Breslau and Berlin have got quite considerable accessions to our stock of original specimens. When I have seen Copenhagen and Stockholm and London again I shall have *seen* almost every original specimen described in Europe and America, and ought to be able to do something good, not from books but from the things themselves.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

I am cutting up dreadfully all the new species, etc., made by all recent workers, myself included in the list, but this work could never have been done so completely except by personal examination. Uncle Alex and all send much love. Mathilde [his cousin] is to be married next month; if I am anywhere near I shall come to see the family again.

At Kiel, Agassiz and his wife spent three delightful days with Dr. Meyer, the zoölogist, who had a beautiful place surrounded by magnificent beech trees, in the most picturesque spot of the harbor, a short distance out of town looking down on Kiel Bay. From here he went to Copenhagen and Stockholm, where he spent most of his time examining collections of Echini.

On their way back to Switzerland they stopped for the day at Freiburg, of which incident Agassiz writes: "I took Annie to all the old haunts in the town, showed her where we lived, took her behind the town on the Schlossberg to see the view, and we also made an excursion to the Höllenthal, so that she got a very good idea of the Black Forest; we had magnificent weather for it. Little did I think when I left Freiburg twenty-two years ago, jumping on my violin as a farewell salute, that I should return next time as I have, a comparative nabob, if the mines hold out till I can pay my debts."

Leaving Mrs. Agassiz, who had become somewhat tired with rapid traveling, at Lausanne, Agassiz continued his scientific pilgrimage alone, only to be shortly turned back by the outbreak of the Franco-Prussian War.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

TO MRS. LOUIS AGASSIZ

WÜRZBURG, July 8, 1870.

I was not very lucky in Heidelberg, found no one at home. Helmholtz was attending a funeral and had left for the day, and Pagenstecher was also absent for a couple of days, so I got nothing here except a very pleasant excursion to the Castle and the Hills (all by myself, however), and in the evening started for Würzburg, where I found Professor Semper waiting for me, who insisted on my going to his house. You know he spent seven years collecting at the Philippine Islands and spent there most of his property, and is now satisfied to pass the rest of his life as Professor in a German University and to work up what he has collected, which is certainly magnificent. If Mr. Lowell is in want of somebody for a really good course of lectures of travels, he could not do better than to invite him to come and give a course; he speaks English well enough to read his lectures, which his wife would brush up; she speaks very nicely, and I think he would be a success.

I dined to-day at Kölliker's. I must say I liked him very much; he strikes me as a most thorough and able man. He looks quite comical; his hair is perfectly white with a thick black moustache; you would hardly give him 40 from his face. I saw also at the Knipe last night, Professor Sachs, the Professor of Botany, and one of the smartest chaps I have seen yet. This morning I have been to see Professor Sandberger, who has some very fine fossils from the Trias; he has a good many duplicates and he will make us an invoice shortly. Here I see the true German way of living perhaps as well as I have yet seen it. The few evenings thus far

Digitized by Google Original from UNIVERSITY OF MICHIGAN

have been spent at the Knipe, but there is an improvement, I fancy, since father's days; in fact ladies go there now with their husbands, they having found that their husbands would go and spend their evenings they have determined not to leave them to their own devices, but to lend them the charm of their presence and beer at the same time.

From Leipzig he writes a few days later: —

"From Würzburg I went to Leipzig, stopping between two trains at Erlangen, a rather round about way, to pay a visit to Ehlers. He came to meet me at the railroad station and, as frequently before, I recognized him at once from his photograph. He took me to his house where we supped and had a pleasant chat of a few hours.

"I found also there that Ehlers had in his Museum all the original Echini described by Klein, but as it would be naturally a most critical kind of work to identify them all, and would take more time than I can possibly afford, he will send me the whole collection over for examination in the fall. This is for the 'Revision of the Echini' a most remarkable catch, as it will settle the history of many of the old things of the time of Linné."

TO MRS. LOUIS AGASSIZ

MANNHEIM, July 17, 1870.

Annie sent me at Jena a letter from you from Jamaica Plain. How pleasant to have father and Pauline both so well again, and it really looks as if care would set him up again completely. I have been travelling like a steam engine. The rumors of war kept growing thicker and I did not want to get caught, as I had left the Rhine

Digitized by Google Original from UNIVERSITY OF MICHIGAN

parts for last moment, for which I am now very sorry, as I come too late for my mining excursion. I was to have left this morning for Saarbrücken on the French and Prussian frontier, where there are some excellently managed mines with capital machinery, and last night railroad was taken possession of by the military, so there is no passing at present, and I shall wend my way back to my family a couple of days earlier.

From Leipzig I went to Jena, saw Haeckel, but not Gegenbaur, who was very sick with a malarious fever. Haeckel I liked extremely; he is, however, of a most enthusiastic disposition, and in the Okenistic[1] direction he has taken he is doing himself a great deal of harm. He has left the positive for the speculative, and indulges in fancies which are more like the dreams of Swedenborg than Natural History. We got along very well, though he fought rather shy of entering into any discussion. They have quite a nice Zoölogical Laboratory there, with just enough collections to teach, and the anatomical part is really good, with a collection of skeletons which would do honour to a large Museum.

From Jena I went to Marburg, passed an evening with Claus at the Knipe, and found him much less of a man than I had expected from his work; he goes to Göttingen in place of Keferstein.

At Geissen I saw Schneider; he is a real worker and the collections here are quite remarkable. Bischoff (of Munich) has left here a very large collection of Embryos and fine anatomical preparations and skeletons of higher animals, while Leuckart, who was the zoölogist for more than nineteen years, has left an equally valuable collection of preparations for the invertebrates;

[1] Lorenz Oken, 1779–1851.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

as a collection for instruction it stands unrivaled in its preparations and the quality of material. Of course it is not pretty to look at.

I then went to Bonn, paid a visit to Max Schultze and Troschel, who both want to be remembered to father; met there Ehrenberg on a visit to his son-in-law, Professor Hanstein, the botanist. At Frankfort the Museum of the Zoölogical Society is really good and *very large* and exceedingly well arranged in some points. I was very glad to see it, though I found nothing specially new there, except Rüppel's things from Red Sea. The Zoölogical Garden is very pretty; it is small, but being old, the trees are large and the effect very good, the animals being well taken care of. I shall wait here to-day for further news, and if I cannot go to the scene of mines, will paddle back to Switzerland and join my family, who will be disconsolate at my early return. This has been to me the most interesting of all my trips.

Agassiz at this time bore a striking resemblance to Bismarck, and this led to an amusing incident at the hotel in Mannheim. Here he was conscious of being treated with very unusual consideration, but not until his departure for the mines at Saarbrücken, when the landlord refused to give him his bill, did he discover that he was mistaken for the Chancellor. In vain he expostulated and produced his passport; he was met with the smiling rejoinder that it was easy to understand why His Excellency should wish at such a time to inspect the frontier *incognito*, and he finally was forced to leave the landlord unconvinced and unpaid.

Shortly after the train left Mannheim, he found that the Prussians were occupying the main line between

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Paris and Frankfort. The passengers were informed that any one who wished to come back could go no further, but that there was a train ready to return to Mannheim. Agassiz was almost the only one to turn back. On his arrival at the station, the hotel porter beheld him descending from what seemed his private train. Thus, on his reappearance at the inn, he was received with more reverence than ever.

The train to Switzerland was jammed with people leaving Germany; at the junctions were travelers waiting by thousands to get back to France, while mountains of neglected trunks lay piled up on the platforms. To add to the confusion, the bridge across the Rhine, leading to Strassburg, was cut, and the unfortunate exodus was compelled to proceed to Basle. Here confusion reigned supreme; after spending the night on the floor of a hotel, Agassiz in some way got out of the town, and joined his wife at Lausanne.

The family spent the rest of the summer in wandering about in the Alps, among other things visiting the elder Agassiz's haunts on the glacier of the Aar, and hunting up the relatives of his guides at Meiringen. A few extracts from a letter to Mrs. Louis Agassiz in September tell something of the exciting events of the day: —

"You hear nothing but war, of course, and the excitement runs very high; in the French cantons the feeling is rather for the French, and the German cantons the opposite, as is natural. It is really melancholy to see how low the French have fallen and what abominable results their government has brought about, a system of lying from the highest officials to the lowest, corruption

Digitized by Google Original from UNIVERSITY OF MICHIGAN

of which I hope we may never have any idea, and a want of patriotism which must make the few who want to save France boil with rage. Imagine a country of forty millions of inhabitants and you cannot raise more than 250,000 men for the defense of Paris! It is something incomprehensible. A large city like Lyon raising 1500 francs ! ! ! ! for the defense of the city. Everybody who had the means running away, as we can see here. Switzerland is flooded with French refugees in good circumstances abiding their time; it is really sickening and a disgrace to France. . . .

"The French need this terrible lesson to waken them up, and if there is anything left in the French, they will come out a great nation; but I am afraid it is all over with them and they are not to be hereafter anything greater than a third-rate power. It is to me perfectly astonishing that a man like Napoleon, who certainly was no fool, could have been such an idiot as to measure himself with the Germans. Why, the first Colonel in the German army knows more about France, their organizations, their armies, than their greatest Marshals. I should feel safer behind an ordinary German General than behind the lot of thieving Marshals like Bazaine, Failly, Vaillant, who have made their fortunes, like Palikao, plundering either in China, Algeria or Mexico, and whose notions of international rights and usages seem to have been borrowed from these very highly civilized people to judge from their actions, who all deserted the sinking ship of the Emperor at the first signal and have behaved like cowards, only caring to save themselves, and ready, as Bazaine now is, to betray for a round sum, which *he has named* (two millions francs), Metz. . . .

Digitized by Google Original from UNIVERSITY OF MICHIGAN

"The French, we hear to-day, have refused the terms of armistice offered by Prussia with their usual insolence, imagining they can change the face of things by a few high-sounding words, and have forthwith made a proclamation telling Prussia to come on and do their worst, so that next time they come to terms they will be much more ill-treated, and it really seems as if it would be their fate to suffer what Prussia had to bear in 1806 and be occupied by a German army till they come to terms. As for the Germans, they are I think making use of Prussia to become a great nation, and the element which will be added by Württemberg, Baden, Bavaria will, with the opposition in Prussia, counterbalance much of the power of the Prussian nobility. But of course there is great danger of their becoming overrun by military rule, instead of tending to a central German Diet, a German army, navy and customs, as they all hope now. The German papers are now beginning to get worked up; they were calm enough at first, but now, after their successes and the inability of the French in understanding their situation, they are beginning to smart under their losses, and will make France pay the full penalty of all the suffering they have had. If Napoleon could only be made to pay his share. In Switzerland they have behaved very well, and have really done more in assisting the French and German wounded and the regulars, than has been done in the whole of France to save their country."

The end of October saw the Agassizs again in London, which they had reached by way of Germany and Ostende.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

TO DARWIN

LONDON, Oct. 22, 1870.

MY DEAR MR. DARWIN: —

Hearing you are in town, I write to ask you if you will allow me to come and bid you good-bye before we sail. I go to Ireland on Thursday next, in the evening, to see the plunder of the last Porcupine Expedition, but any time you can receive me before that it would be a great pleasure for me to see you again before I leave this side of the Atlantic, where I have had such a charming reception and have I trust learned a good deal which will not come amiss in America. With the kindest remembrances of Mrs. Agassiz and myself to Mrs. Darwin and your family, believe me always

Yours very truly,

ALEX AGASSIZ.

TO MRS. LOUIS AGASSIZ

BELFAST, Oct. 30, 1870.

Here I am again up at the poles, having left Annie and children in London, while I took a run here to see the collections brought home by the last expedition of the English dredging; they have not found much compared to what they did in 1869, and in the Mediterranean their work really amounted to very little. The Mediterranean seems to be a deep sea of some 1500 fathoms deep, in which very little is found below a certain depth, which really accounts for Forbes's former view that below 300 fathoms nothing lived. Such is actually the case in the Mediterranean, but this seems likely to be the case with all *inland seas* where there is no *circulation* of water, for the shallow water at opening of Straits of Gibraltar is as much a barrier to the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

circulation of fresh cold sea water in the Mediterranean as a stone wall would be. On the coast of Portugal they were more successful, and carried their former geographical work well along, showing the same animals very much as further North. The main thing of the Expedition is a magnificent new Pentacrinus, almost as large as the West India form, and some very magnificent sponges (vitreous). I have picked out while here a fine series of the Echini they have collected, as I could work them up as fast as we looked at them, and have made all arrangements necessary that we shall get duplicates (the first series) of all they have in way of Corals, Crustacea, and Mollusca, and Echinoderms, as fast as they are worked up and ready to be distributed. One of the fine Pentacrinus and young sponges I have taken along as trophies of my expedition here.

I was greatly astonished the other day in London to find Professor Peirce in same hotel with us. I have had a good deal of talk with him about the deep-sea dredgings, and hope he will be able to go on and do something also on the Pacific Coast. I should like to take a trip out there again. I look upon California as my cradle in Natural History, and now that I know a little more should like to go back there. I had a very good look in British Museum at their collection of Fishes; it is in *admirable order*. Günther has certainly everything very accessible, well named, and, what is far more important, very well preserved, and their collection of Reptiles and Fishes is wonderful. The osteological collection I was greatly disappointed in. The Palæontology is marvelous.

The end of November found him once more at his post at the Museum, busy with his "Revision of the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Echini." Although the robust vigor of his early youth was shattered, he returned much improved in health, and the next three years were quiet and happy ones, the last he ever knew. At first he settled again in the little house in North Cambridge, but as the dividends from the mines at Calumet began to pour in, the condition of his finances changed very materially. In the spring of 1871 he hired "Shady Hill" of Professor Charles Eliot Norton, who was then abroad. Since those days, the estate, which lies close to the Museum, has been divided, but at that time the pleasant, roomy, old-fashioned house, resting on a low hill, looked over gently sloping pastures to a miniature forest.

In this charming setting the family remained until the fall of 1873. Then, on Professor Norton's return, Agassiz went back to his father's house, for a few months as he supposed, while looking about for suitable quarters. His summers were spent at some convenient place on the New England coast, one of them in a little farmhouse near Newport, Rhode Island, not far from the spot that afterward became his home. At these seasons he was constantly busy at his marine work, for which he improvised a temporary laboratory wherever he happened to be.

Among his other investigations at that time, his study of Tornaria led to some interesting results. These small animals, so called from their active habits, are found among the many little creatures which float near the surface of the sea. They bear a striking resemblance to the larvæ of the ordinary starfish of the New England coast, and it was supposed that they were the young stage of some genus of starfish. Acting on a hint from Metschnikoff, Agassiz was able to show that these animals

Digitized by Google Original from UNIVERSITY OF MICHIGAN

were in reality the young state of certain marine worms known as Balanoglossus.

He was also much occupied in the study of the embryology of various jelly-fish. The following quotation from his publication on this subject is interesting as showing his attitude toward evolution at this period. Speaking of Haeckel's Gastræa theory, he says: "If we need an ancestor for our phylum why not at once go back to the cell? There we have a definite starting point, a typical element which underlies the whole of the animal kingdom and which forms the walls of Haeckel's gastrula. Then we shall all be agreed and when we frankly state that all organisms are derived from a primitive cell and from its subsequent increase, we come within the range of positive knowledge, but we are unfortunately as far as ever from having for that reason been able to trace a mechanical cause for the genetic connection of the various branches of the animal kingdom."[1]

TO A. MILNE EDWARDS

CAMBRIDGE, Mar. 17, 1871.

We have just heard that communication has been reëstablished, and I seize the first opportunity to write you a few lines and to ask for news of yourself, your father, and of all the gentlemen of the Jardin des Plantes, who were so kind to me during my stay in Paris. I much regretted not being able to pass through Paris to say good-bye before my departure. In Switzerland I hoped up to the last moment that peace would be declared, and that I should not be forced to leave

[1] "Embryology of the Ctenophorae," *Mem. Am. Ac.*, vol. x, no. 3, p. 382.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Europe without being able to revisit the Jardin. But I hope that, now I have found the way, it will not be the last time. Everything that you will kindly tell me about the condition of the Jardin will be most interesting, for no one here can form an idea of what you must have suffered during that abominable siege. Every one rejoices that peace is at length declared, and I am sure that no one can sympathize more than the Americans with all that you must have undergone during that horrible war, which seems to recall the dark ages rather than the nineteenth century. Everywhere in the United States people are busy collecting funds for the unfortunates that the war has left without resources — and I hope that the money may arrive in time to do the good that is hoped for.

I trust that all this will not lead to a military epoch in Europe, and that peace will at length teach the natives of Europe that all progress is impossible without the advancement and cultivation of science. Our war had the effect here of rousing our best sentiments and developing in the highest degree all that leads to culture; and I hope that it will be the same thing in France. I do not write you more at length of what is happening here, as I have just got back from the West where I went immediately on my arrival here. My father is practically entirely recovered, and I hope that soon he will be able to take up his work as usual. Do you intend to finish your work on the Limulus? Send me a word and it will give me the greatest pleasure to send you some. As soon as communication is thoroughly established I will send you some memoirs of the Museum.

My wife wishes to be most kindly remembered to

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Mrs. Edwards. Will you kindly also remember me to your father.

The following is in answer to a letter that cannot be found:—

FROM DARWIN

DOWN, BECKENHAM, KENT,
June 1, 1871.

MY DEAR MR. AGASSIZ:—

Very many thanks for your kind letter and curious facts about the fishes. What an extraordinary number of complex and wonderful structures have been developed in relation to sex!

I am also particularly glad to hear about the pedicellariæ of the Echinodermata, the homologies of which I did not in the least know. I must now find out the homologies of the "Birds-beaks" and serrated bristles of the Bryozoa, which I remember watching in old days with astonishment.

I am thinking of bringing out a new and cheap edition of the "Origin;" and if so I should give a chapter to answering, as far as I can and space permits, Mivart's very clever book. I have no doubt the book will produce a great effect on many; and you will think it blind prejudice when I say it has had none on me. There is not one new point in it, though many are admirably illustrated. Mivart never racks his brains to see what can be fairly said on [the] opposite side, and he argues as if I had said nothing about the effect of use or the direct action of external conditions: though in another part of his book on these points, almost every illustration is taken from my writings and observations.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

But I will not bother you with more remarks on this head.

Pray give my most sincere respects to your father. What a wonderful man he is to think of going round Cape Horn; if he does go, I wish he could go through the Strait of Magellan.

With very kind remembrances from all of us to Mrs. Agassiz, and with many thanks from myself,

Pray believe me,
Yours very sincerely,
CH. DARWIN.

Professor Agassiz sailed in the Hassler for a dredging expedition around South America in December, 1871. This time during his absence the work of the Museum management did not all fall on Agassiz's shoulders, for Mr. Thomas G. Cary, the brother-in-law of the elder Agassiz, had charge of the finances.

TO DARWIN

CAMBRIDGE, March 4, 1872.

Many thanks for the copy of the new edition of the "Origin of Species," which I have just received from you. There are several points, especially in Embryology, which I shall take some other occasion to write you about, which may be of general interest. I am getting on toward the end of the Report on Echini from the deep sea of Florida, and hope to be able to send you a copy before long. The number of young I have been compelled to examine has led me to modify my views of the nature of genera, species, and in fact of all subdivisions. I cannot find anything that *is stable*, the greater the material in space and number (age) the

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

more one is adrift to get a correct diagnosis of a genus or a species, and the gradual passage in Echini of the most widely separated groups leaves in my mind but little doubt that our classification is nothing but the most arbitrary convenient tool, depending upon the material at our command at a special time. The generalizations to which I am led from the careful study of such a small group as the Echini I shall publish at the end of my "Revision of the Echini" and as the Plates for the descriptive part are far advanced, I hope I shall not be long delayed. We have excellent news from the Hassler Expedition from Rio. Not much was expected from the dredging on this side of Cape Horn owing to the lateness of the season, but the single haul made off the Barbados must have been a wonderful catch of which I trust we shall hear and see more by and by.

TO DARWIN

CAMBRIDGE, Dec. 9, 1872.

I have to thank you for the trouble you have taken in sending me a copy of your "Expression of the Emotions," which has duly come to hand. I have not had a moment to look into it, in part on account of the work of distributing some collections which have lately arrived, and in part owing to the great fire which has devastated Boston, and which has affected us all more or less seriously. I have been hit pretty hard, not in a money way, but what is worse infinitely, I have lost a year's work by the destruction of six Plates of anatomy with the original drawings, of which I have not even a sketch. They had been sent to Boston the morning of the fire to be lettered preparatory to printing. In addition I lost all the stones of the first parts of the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

"Revision of the Echini;" fortunately about three fifths of the edition of the Plates had been struck off and was safely housed at the Museum. This leaves us with rather a short supply, but the remainder of the book, which I hoped to get out before spring, must be delayed a long time, as I feel neither heart nor have I the time to start fresh and do all this again just as it was completed. I have sent to the Zoölogical Society a package for you, which please claim from Mr. Sclater. I presume it should arrive a few days after this letter. I have made pretty extensive use of the new processes of photographic printing in my book, and from what I have succeeded in obtaining trust it will hereafter be possible to supersede the old lithographic processes, which are wasteful in time and money, and not half as accurate.

The famous Challenger Expedition left England, with Wyville Thomson as the naturalist in charge, in December, 1872, and by April, 1873, the ship was in Bermuda. Wyville Thomson wrote Agassiz from there, asking him if he could not pay them a visit in May, when they touched at Halifax.

Agassiz eagerly accepted this invitation, and ran up to Halifax, where he was a guest of the Challenger for a few days. The younger naturalists of the expedition were all pronounced evolutionists, and as the name of Agassiz conjured up to them opposition to these views, there was much curiosity among them as to what sort of a man Alexander Agassiz was. Sir John Murray, one of the staff, in his address in memory of Agassiz, speaks of the excellent impression which the young naturalist made on every one, and how different they found his opinions from those of his father. "He was

Digitized by Google Original from UNIVERSITY OF MICHIGAN

cheerful, confident, and possessed a fund of dry humor." Most enthusiastic about their collections, he was able to tell them many things that they did not know, especially about Echinoderm and Annelid larvæ, and showed how he had proved that Tornaria was the larva of Balanoglossus. In short, he created such a favorable impression that it was freely prophesied he would have a very brilliant scientific future.

By the end of the year the "Revision of the Echini" was completed. It represented an immense amount of work, and its author was at once recognized as the leading authority on the subject. The text consists of 770 quarto pages, and is illustrated by 87 plates, besides numerous wood-cuts in the text, and seven maps showing geographical distribution. Part I treats of the literature, nomenclature, synonymy, and geographical distribution. Part II takes up the Echini of the East Coast of the United States, including the Pourtalès collections. Part III deals with the description of the species of recent Echini, and Part IV contains the structure and embryology of these animals. In his short autobiography, Agassiz says of this work: "Nothing pleased me more than to have been able to present the cost of these volumes to the Museum; and on the other side the recognition it received from scientific men, and the position it took as the standard work on the subject was no less satisfactory to me."

A few words from the last pages of the "Revision" may not be out of place here: —

"It is astonishing that so little use has been made of the positive data furnished by embryology in support of the evolution hypothesis, and that so many of the sup-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

porters of the Darwinian theory have been satisfied to build castles in the air, which they have been obliged to pull down in rapid succession. . . . It is only in a few orders of the animal kingdom that we have even the first beginnings of the needed paleontological and embryological material to serve as the basis for the comparisons which might lead to some definite results. Yet these comparisons are generally instituted on such a grand scale, and with such utter disregard of the exceptions, that their authors can hardly expect us to follow them in the paths they tread, where theory takes the place of observation. No one appreciates more than I do that the explanation of the theory of evolution, as given by Darwin, has opened up new fields of observation in many departments of biology, the importance of which can hardly be overestimated. . . . But his disciples cannot ask us to take as proved beyond question all the vagaries regarding this and that ancestor of the great animal kingdom, about which they talk with such sublime confidence. And when I am introduced to an archetype in a group where we have neither paleontological nor embryological evidence, or when I am asked to believe in a genealogical tree of which neither the roots nor the branches have ever existed, as far as we now know, I am no longer dealing simply with an hypothesis, but with the wildest speculation."

Digitized by Google Original from UNIVERSITY OF MICHIGAN

CHAPTER VI

1873–1875

LAKE TITICACA

Louis Agassiz, whose health had caused more than usual anxiety for some months, died on December 14, 1873. Eight days later, Alexander Agassiz's young wife succumbed to an attack of pneumonia, the result of a cold contracted on the distressing night of her father-in-law's death. The innermost chamber of a strong man's nature is sacred ground. This lifelong sorrow increased the natural reserve of his character, which afterwards seldom melted except in the most intimate and congenial surroundings; while far below, behind an almost impenetrable wall, where few indeed ever glimpsed, lay a wealth of affection, a delicacy of feeling, a power of self-sacrifice, and a capacity for suffering, such as have been given to but few men.

Two or three extracts from his letters should make it clear that he now faced life as a permanently saddened man. In writing to Huxley some months later he says: "Few young men have reached my age and have attained, as it were, all their ambition might desire, and yet the one thing which I crave for, and which I want to keep me interested in what is going on, is wanting. How gladly I would exchange all that I have for what I have lost. But I will not burden you with my sorrows."

On the first anniversary of his wife's death his reserve broke down in a beautiful and pathetic letter which

Digitized by Google Original from UNIVERSITY OF MICHIGAN

cannot be published here, written from a remote corner of South America to Mrs. Louis Agassiz. It was the cry of a broken-hearted man who, under a restless energy, was struggling with the burden of a grief that was almost more than he could bear. — "I feel as if I were acting a constant lie, but it is a harmless one which I must make up my mind to keep up for many a weary year."

In writing of a visit that Agassiz made to Sir Wyville Thomson in the fall of 1876, Sir John Murray says: "When he arrived in Edinburgh I referred to the death of his wife, but he held up his hands and said, 'I cannot bear it.' His expression was such that the subject was never again mentioned, although he frequently spoke of his boys." After this visit Agassiz writes, "I can't tell you what a pleasant time I have had in Edinburgh, thanks to you and Lady Thomson. It is really the first time since the death of father and my wife that I have felt in the least as if there were anything to live for, and I hope you have put me on the track to get into harness again and do my share of the work I have to do — if not with pleasure at least cheerfully."

Although he was never again the same man, he took up the burden of life so bravely that few realized the depth of the shadows under which he worked. But his intellectual activities were undimmed, and in the unfailing interest with which he pursued the secrets of nature, in the steadfast endeavor to increase the sum of human knowledge, he found his "Everlasting Yea."

A few words of his show the beacons that guided him henceforth: "To live our lives as they have been made for us, and live in hope, do the best we can, work hard, and have as many interests as we can in what is going on around us."

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Mrs. Louis Agassiz took up the shattered remnants of the broken home, and presided over the Quincy Street house for the rest of her long life, always tenderly guarded by her stepson from the outside world and fondly cared for in her declining years. The family consisted of three little boys, "none of whom inherited from his father or grandfather any scientific tastes." These children Mrs. Agassiz brought up with the loving hand of a true mother; not always an easy task, for during the long absences of their father these healthy young savages were sometimes a troublesome charge, and must have caused their beloved grandmother many an anxious hour.

Under the shock of his terrible double blow, Agassiz suffered a relapse of an old malady. The exact nature of this disease was never understood, but the symptoms were distressing and alarming; and for many years, with few intermissions, he lived in the constant expectation of dropping dead at any moment.

When he was again able to work, his first occupation was to help his stepmother collect the material for the Life of his father. As he became stronger, his former studies, combined with his desire to continue his father's interests, left him but little time. Thus the work on the Life fell to Mrs. Agassiz, and his share in the book was limited to advice and criticism.

TO ERNST HAECKEL

CAMBRIDGE, Jan. 28, 1874.

Your kind note written soon after father's death finds me overwhelmed by a still greater sorrow which has fallen upon me like a thunder-clap out of a clear sky. I had the misfortune a few days after father's

Digitized by Google Original from UNIVERSITY OF MICHIGAN



THE CAMBRIDGE HOUSE

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

death to lose my wife, who died very suddenly from a violent attack of pneumonia. I had made, previous to father's illness, all my arrangements to pass the winter at Nassau on the Bahamas, and I anticipated much profit and good work from a prolonged visit there. But alas, now all seems of very little consequence, and I am utterly unable to get reconciled to an existence which is well-nigh intolerable, and from which all the mainsprings which usually act upon men of our age, are taken away; at present I can find no incentive for anything and I can only hope that in the course of time my interest in my children and in my work may ultimately reconcile me to a sort of passive life. I shall try and carry out, to the best of my abilities, the many plans regarding Penikese and the Museum which were started by my father, and I shall at least have the melancholy satisfaction of knowing that in his case at least his views, whether right or wrong, and his dearest wishes, will be faithfully executed, and that I may raise a monument to him expressing what he hoped to be able to show, better perhaps than he himself would have done, because I shall not be constantly drawn aside by new plans and shall not have the incessant temptation of remodelling as I go along.

In some way, men who have made their mark in the history of science disappear from the very history of the centres where they have been most active, because their successors are always in such a hurry to show how much wiser and more learned they are than their predecessors. To prevent this I will consent to saddle myself with a great deal of executive work which must of necessity curtail my own plans of work; but that which before seemed to me of so great importance mat-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

ters now but little, and I am ready for anything. I duly received your two pamphlets, but have had no heart for anything and am not in mood for appreciating anything either, and will wait till I am more myself again. I have just sent off to you Part III of the Echini and the Plates of the whole. The work was finished just a few days before father was taken ill, and of course has been delayed since that time. Part IV is in hands of the binders. Let me know what you have not of our publications in the University Library and I will complete your set. I think I have sent your University something? — but I cannot tell now, and the simplest way is to ascertain directly from you.

This letter gives an excellent insight of his attitude toward the Museum. His own researches were always the dearest of his intellectual children, and he never would have persisted, in the face, as he thought, of the indifference of the public and the lack of sympathetic support from the University authorities, in devoting the thought, time, and money which finally converted the dream of his father into a solid reality, had he not been impelled by a sense of duty and filial obligation.

At the time of the death of Professor Agassiz, four fifths of the north wing of the Museum had been completed. The original section of the building was crowded to the utmost, and the Museum had an income of about $10,000. Its prospects were not encouraging, and it was feared that it might share the fate of the many enterprises that have perished with their founders. But Agassiz thought otherwise, and in a little over a year a memorial fund of over $300,000 was collected. Of this fund, $125,000 was given by Quincy A. Shaw,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

$55,000 by Agassiz, and $50,000 by the State. The remainder was collected by popular subscription. The hold which Agassiz had on the affections of his miners at Calumet is shown by a subscription of $1215 from 1233 employees at a time when the Calumet & Hecla Mining Company was not employing more than 1400 men.

Thanks to Agassiz's care and his lavish financial assistance, the growth of the Museum proceeded steadily; not only the building and the popular exhibition rooms, but also the scientific materials and the resources that made them available to students who were competent to use them. By 1882, the northwest corner piece was completed. This left the rest of the main structure for the future extensions to be devoted to natural science, the south wing having been allotted to the Peabody Museum of Archæology.

The latest interest of Louis Agassiz suffered a different fate. Mr. John Anderson, of New York, had given the Island of Penikese and a fund of $50,000 to the elder Agassiz for the purpose of founding a summer school of marine zoölogy. This school, opened in the summer of 1873, was the first of its kind in America, the pioneer of all the marine laboratories and zoölogical stations since founded along our shores.

Penikese is a little island of about one hundred acres, situated at the extreme entrance of Buzzard's Bay, on the south shore of Massachusetts. From the first, Alexander Agassiz had been opposed to establishing the school on this spot, since he foresaw the practical difficulties of managing it in such an inaccessible locality. Nevertheless, on his father's death he undertook as a sacred duty the uncongenial task of directing the school. With some misgiving he started to organize the in-

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

struction for the following summer, for he feared that his influence would not be sufficient to secure the support that had been so readily accorded his father. The latter's friends, however, rallied to his aid, and he soon filled his teaching force, largely from those who had helped the preceding year. There were more applications from students than could possibly be filled, the great majority of the pupils being scholars of the former year. As soon as the school was opened, it became evident that Agassiz had undertaken more than his health would allow; the doctors ordered him to leave the island and take as complete a rest as possible. In his absence Dr. A. S. Packard and Mr. F. W. Putnam took charge of the school, and brought the season to a successful close.

TO WOLCOTT GIBBS

NAHANT, Aug. 8, 1874.

I was obliged to drop Penikese. It broke me down completely, and as that is the last of the Institutes started by Father I shall have to do in the future what seems to have done so well this summer, merely get the people to go there for a few weeks, and direct from a distance. Putnam and Packard who have had charge have done admirably and worked most faithfully. Everything has run to the satisfaction of all the pupils and there has not been a word of grumbling from anybody. On the contrary, they all have expressed the utmost gratitude and satisfaction, and when I remember what chances I had for work when I began, I don't wonder at it. I hope to go there a few days yet, but shall not do much — as long as I am idle I flourish, but the least work unnerves me completely so that I seem to have no con-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

trol over myself. If matters do not mend I must pack up my traps and go off for a few months for an entire change of scene.

The following winter, Mr. Anderson withdrew his expected support. As the school was heavily in debt, permission was obtained from the Massachusetts Legislature to sell the island and dissolve the corporation. Later, Penikese became a small-pox hospital, and finally a leper settlement of the State of Massachusetts.

In the fall of 1874, Agassiz planned a trip to Chile and Peru for the purpose of visiting their copper mines, exploring Lake Titicaca, and collecting antiquities for the Peabody Museum. Accompanied by Mr. S. W. Garman, of the Museum staff, he left New York in November, taking with him a large outfit of ropes, dredges, sounding lines, thermometers for deep-water temperatures, and all the necessary materials for preserving whatever collections they might make in the lake.

From Panama he took a steamer down the west coast that stopped three days at Callao. This enabled Agassiz to run up to Lima and get in touch with the government officials and Mr. Henry Meiggs, of the Mollendo-Puno Railroad. Continuing south, he left Mr. Garman at Mollendo to take the baggage some three hundred miles to Lake Titicaca, over the astonishing railroad that scrambles through passes in the Andes only a few hundred feet lower than Mont Blanc. He himself continued to Valparaiso. A few days there enabled him to make the acquaintance of various people in the world of copper, pick up what information he wanted, and arrange for seeing some of the mines.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

TO MRS. LOUIS AGASSIZ

PISAGUA, Jan. 19, 1875.

MY DEAR MOTHER: —

I left Valparaiso as I intended by the Columbia and arrived the following day at my first stopping place, Coquimbo. I went there to see the great smelting establishment of our principal rival in copper, and it certainly is admirably arranged and carried on, on the most extensive scale. One of the partners is the owner of the largest copper mines of Chile; the other owns immense coal mines near Lebu. So that between the two they make an excellent combination, bringing the coal up here in their own steamers and taking down copper ore for other people from the mines of the district. The head man of the establishment at Guayacan is a Scotchman, extremely well educated and a great friend of the United States, so we got along very well; he is also an excellent botanist and quite an amateur of fossils. He showed me some very extensive beds of fossils, and I hope that on my return from the mines I shall, while waiting for the steamer, be able to do something. I wish the Hassler had put in at some of these Chile ports; the geology is most interesting, and I have no doubt father would have enjoyed his study of them very much, and then there were so many hands to collect that very fine collections of fossils could have been sent home; of course with me, having no means of transport at hand and being alone, I should waste too much time did I attempt to make extensive collections. I am obliged to be satisfied with notes and looking at things, for one man cannot do everything.

The railroad from Coquimbo to Ovalle, which is about

Digitized by Google Original from UNIVERSITY OF MICHIGAN

twenty miles from the great mining centre, is a remarkable piece of engineering; you climb up round spurs of mountains and over mountains at an inclination which is fearful. But like many things done by our English friends, the whole thing is spoiled by the absurdly broad gauge they have adopted, as broad as that of the Erie Railroad, to do a little two-penny business of one train a day, which a diminutive railroad like some of the mountain railroads of the United States would do at half the cost. What a pretty country this coast range would be were it only green, but you see only here and there a few green bushes; to be sure they say that in spring it is covered with wild flowers, but as in California it lasts but a very short time. Some of the transverse valleys, where a little water still winds its way among the pebbles, are masses of green, and give you an idea of what this country might be with irrigation. There must have been water here in plenty in olden times, for the town of Ovalle and the terminus of the railroad from Coquimbo are placed in the broad bed of an ancient river, and high above the town rise the old terraces over two hundred feet high, through which the former river once cut its way and has now left the huge masses of pebbles and cobble stone which compose the surrounding hills. You do not see, even in the Connecticut Valley, better river terraces than found here, only here they are due to the gradual rising of the whole of the Chile coast, so plainly seen by this sort of formation, and by the old beaches high above the present level which you find all along the coast.

I am now beginning to experience some of the pleasures of travelling in out of the way places, and that in Spanish places which beat the worse phases of the French

Digitized by Google Original from UNIVERSITY OF MICHIGAN

all hollow, — four in a room: to be sure it is large and each man has a bed, but it is not pleasant, with the filthy habits of the Spaniards, to be any length of time in the same place with one of them. They look better dressed up to kill, and they never stop smoking; even in bed they indulge in a couple of night-caps and commence the day with a cigarette instead of a bath. From Ovalle it is about twenty miles to Tamaya, a hill which produces about one-third of all the copper produced in Chile. I wish we had the advantages for mining which they have had and thrown away. The richness of this place is something stupendous, and the bulk of it owned by one man who was shrewd enough to see a little further ahead than his neighbors. The drive from Ovalle to Tamaya is over an old sea bottom cut into a deep valley by a former river which is now a mere rivulet. You go the twenty miles in about two hours, in a light open carriage, with four horses abreast, and going full gallop up hill and down. I got to Tamaya just at breakfast time, and after that the Engineer took me in charge, showed me what there was to be seen on the surface and then passed me over to the Mining Captain, a very intelligent German, who, thinking I was a greenhorn, amused himself, as many Captains have done before, in running me up and down the ladders. I very soon tired him out at that game and he after that looked upon me with great respect and I got from him all I wanted.

It is melancholy to see workmen in such a condition as you find them here, living in huts the walls of which are made of cobble stones and a few bunches of grass thrown across the top at an angle form the roof, and in this solitary room men, women, children, goats, and donkeys all live. It is fortunate the climate is so fine,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

yet they are cheerful, carry immense loads on their heads up frightful ways under-ground, get but $15 to $18 à month and never see any better food than black-bread, figs and a few beans, and occasionally a little fat for cooking; add to this that they have little or no water, and that fuel is worth its weight in gold, and you have a dim idea of the condition of the miners here. I don't wonder the owners make money, yet they would make infinitely more had they machinery; but I presume that as long as they can get such willing hands they will keep up their old ways.

The mines here at Tamaya are most picturesquely situated, perched along the steep slope of a high hill about 3000 feet high, above the surrounding plain, and so steep that the houses, shops, etc., are placed one above the other in regular terraces, which look as if they would all scale off; and as for the paths connecting them, except the main road which has been built with great care, they are worse than the worst Swiss passes, and they think nothing of them, travelling over them by day or night, as I experienced to my horror on the expedition I made round the mountain. We got belated, and it was pitch dark while we were up in the clouds trying to get down, which we however did safely, much to my astonishment. This place *was* a mine of wealth, but is now nearly worked out and cannot last much longer; like many other mines in Chile, their future is bad for many of them till better times come again. The view you have of the mountains (of the main Cordilleras) from the top of Tamaya is fine indeed, and if the hillsides could only be covered with verdure, it would be a magnificent panorama, but as you get it, its aridity and barrenness is not pleasant and spoils the whole effect.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

The shape of some of the hills and valleys resembles very much that of the hills at the foot of the Alps, with the difference that one is radiant with verdure and the other very much the reverse.

All the way from Ovalle to Coquimbo you see nothing but mines way up in the air, where the poor natives dig away till they have managed to get together a little ore which they then sell to the smelters. On my return to Coquimbo I went off in the other direction to the end of this mining district to see a few mines near Serena which are worked by an Englishman, a Mr. Lambert, who manages to make an excellent business from a not very rich mine by combining farming, irrigation, smelting, and a good many other things. The way from Serena to Coquimbo leads along the beach, and the tide being high, with a heavy sea running, it was a fine sight to see the huge phosphorescent rollers come in, but also unpleasant as it was so dark that you could not tell if it might not wash the carriage and horses back with it; for half the time you run inside the breakers; however, we had good horses and got through at last to my satisfaction safely to Coquimbo. I had about six hours the following day before the steamer from the North came in, which gave me a chance to collect a few fossils from the ancient Sea Beaches which abound there. I wish I could have time to remain here to study the uprising of the land; there is a good deal to do and quite interesting work it could be if you had time to do it with a surveying instrument and take careful sections of what is exposed. I believe however Darwin has already done something in this line.

We had a very pleasant trip to the next place, Chanaral, which is the only other copper district I shall

Digitized by Google Original from UNIVERSITY OF MICHIGAN

explore. I made the acquaintance there of an intelligent Norwegian, a Mr. Schjolberg, who manages one of the mines of the district and with whom I stayed for about eight days while running about the province. He was most polite and attentive to me and took endless pains to have me see all there was of interest. His wife is quite a pleasant English woman, and they have a charming home in this arid place, which anywhere else would be a gem. The house is built directly upon the rocks of the coast, so close that the spray often covers the immense balcony which runs in front of the place and which is a magnificent play-ground for their children. Behind the house rises a high hill which looks as if it might slide down and crush the village clustered at the very slopes. But the reverse of the medal is, that there is not a blade of grass; all the water they use is distilled sea water which they carry about sixty miles inland on carts to supply some of the mines. This is of course a fearful drawback to all work and when they have to feed large troops of mules, as some of the mines do, it becomes a most expensive luxury.

I made with Mr. Schjolberg an expedition of five days to see the principal mines, and we went a little out of the way to cut across a small spur of the great Atacama Desert; the ride through the Desert was one of the most interesting trips I have ever made, and I learned a great deal of geology and of the agency of various forces of which few people have any idea. You must have been in this country to see what a powerful agent heat is and wind in modifying the landscape of a country and in producing effects which in the northern hemisphere are due to frost, heat, and cold and hot water. But the bleakness of the scene, the utter desola-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

tion and waste of the prospect, I cannot describe. Imagine as far as the eye can see a sea of hills, hillocks, mounds, plains and hills without a particle of vegetation, not a drop of water, the whole covered with stones as large as your fist, with here and there a little efflorescence covering everything with a white crust, and you have an indistinct idea of the great Chile desert. You may form an idea of the waste I passed through during these five days, that all the water we had during our trip, extending over about 120 miles of country, is all brought from one place on the seashore; not a living thing did I see, not a bird, not even a lizard or an insect, and the only living thing was here and there a sickly cactus growing on some hillside. Yet the whole country shows signs of the existence of large rivers which have cut deep cañons between some of the hills, and the whole desert is probably an old lake bottom which has left its trace by the extent of salt and soda to be found in all directions.

Kiss the boys and love to all. Good-bye,

Yours, A. AG.

TO MRS. LOUIS AGASSIZ

MOLLENDO, Jan. 28, 1875.

I go on shore here in a couple of hours and make a start for the Lake at last by rail all the way, but as there is only one train a week I may have to kick my heels for some time. Still I shall not be very sorry for a little delay. I have been rushing so fast ever since I left Valparaiso, and as I spent most of last week on horseback, riding from thirty-five to forty miles a day, and not faring remarkably well either for food or shelter, it was quite a comfort to be back again on board ship. But

Digitized by Google Original from UNIVERSITY OF MICHIGAN

though my last trip to the Niter District was rather hard, it was most interesting, and I have I think now as connected and quite plainly visible to my mind's eye the whole process of elevation of the Chile and part of Peru coasts. The nitrate beds give a most peculiar aspect to the landscape. It is exactly like riding over a dried-up caldron bottom filled with salt, which is left in huge cakes a couple of feet thick, with horns of salt in all possible shapes sticking out in all directions, through which you wind your way.

In some parts where the going is somewhat better, the surface reminds one of a cement pavement in very poor condition. I think our former cellar floor, before it underwent repairs, would give you a capital idea of the surface of the pampa. Immediately below the salt beds, on the edges of the ancient lagoons, the nitrate is found; it is simply blasted out, and the whole extent of territory on which it occurs looks like so many earth works half begun, or as they would look after a heavy cannonading. So that you can readily trace the course of the beds on the hillsides by the hills of refuse neatly piled or heaped up all round.

Under these nitrate beds are found beds of gypsum and of fine clay, which are useful in their way, the one to hold water, more or less brackish of course, which finds its way from the mountains and is the salvation of the district; the other makes an amount of dust of which I had no conception, and as you ride along you are nearly suffocated with this salt dust getting into your eyes and ears and mouth, making you feel as if you wished to be soaked in any fluid available. The result is that all the employees up here drink like so many sponges and keep up a continual soaking, for which

Digitized by Google Original from UNIVERSITY OF MICHIGAN

there is some excuse if they soaked in a milder liquid than brandy.

The Nitrate Desert is an immense plain about seventy-five miles wide and extending from Pisagua, the northern limit, to the northern part of Chile. It is connected to the coast by one of their breakneck railroads, which is so steep that they hardly manage to do any business, the locomotive being fully occupied in taking itself up and down again. As the Pampa is already some 3700 feet above the level of the sea, it is quite cool in the evening, but very hot and dry during the day while the sun is out. From one of the small hills, which we ascended on horseback, you have a very fine panorama of the Cordilleras, with its deep gorges extending into the Pampas and forming innumerable cañons, old river-beds now completely dry, or through which a mere apology of a creek shows itself here and there and in which you find their so-called farms, where they raise a little clover and, by irrigating, a few vegetables, as long as the water lasts.

I picked up quite a lot of fossils in one of the valleys at what must once have been the beach. For to my great astonishment I found several species of recent corals *attached to the rocks*, at a height of more than 2900 feet above the level of the sea. What a rise of the land there must have been, and that in a comparatively recent period, for this to be possible. The more I see of South America, the more I feel inclined to look upon natural causes acting slowly as fully capable of producing all the changes necessary for any necessary combination on the earth's surface; and when you see the constant struggle of animals and plants to maintain themselves, and the remarkable manner in which they often adapt them-

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

selves to circumstances, I don't wonder that Darwin has taken the bent toward natural selection.

On my way back from the nitrate beds to Pisagua, I rode on horseback through the whole ground once occupied by the sea, and was able to follow it step by step as it receded or as the land rose. At Pisagua I had a couple of days which I spent in packing my collections and in digging up a few Indian graves, from which I collected a very fair sample of the contents of these graves of this part of Peru for the Archæological Museum. As they are identical in time with those of Arica, I spent my time at Pisagua, where I was comfortably established at the house of a Mr. Jones, the manager of one of the large companies of Nitrate. I must say the hospitality of the people on this coast is something overpowering. Since I left Valparaiso I have only spent three or four nights in a hotel; you go as a matter of course to people to whom you have letters of introduction; they would think it very strange if you did otherwise; and then not only do they take you in, but they literally devote themselves to you and make out your itinerary, pass you on to their friends, who in their turn do the same; and so it goes from one friend to another. Were this not the custom you would have the pleasure of spending your nights in the open air or in the huts of workmen, sleeping on the bare floor and living on bread and water.

The revolution in Peru is now completely ended so I shall have no delays on that score. We took in at Ilo the greater part of the soldiers who had been left to watch the revolution, such a looking set of wild Indians I never saw. I should think the Government would want a second army to watch the first. They must be glad

Digitized by Google Original from UNIVERSITY OF MICHIGAN

indeed to have them on the way to Lima again safe and sound without their having passed over to the enemy.

Lake Titicaca, at an elevation of 12,500 feet, on the boundary of Peru and Bolivia, is a sheet of water some 120 by 40 miles, about half the size of Lake Erie. On arriving at the little town of Puno, on the shore of the lake, Agassiz found that Mr. Garman had chartered a small schooner, and was off on a dredging expedition. One may imagine his surprise to see the cows in the neighborhood, finding nothing to eat on shore, wade up to their middles in the lake, and dive bodily in search of water weeds, a habit which he noticed had as yet produced no apparent effect on these amphibious animals, although carried on for a good many generations.

TO MRS. LOUIS AGASSIZ

PUNO, Feb. 20, 1875.

I wrote you such a shabby letter last time; what with the hurry and the difficulty of finding room for a peaceful time, it seemed as if I never would get a moment. I have been living in Puno on board a railroad car fitted up for the engineers, in which I have a bunk, and naturally the space at my command is not large. The car has at one end a small kitchen, then comes a small dining room with three bunks at one end, then a space for two bunks and a little bit of a parlor at the other end. It is very compact and cozy and enjoys the name of "Saints' Rest;" it is very appropriate for this country, as the saints are always much better taken care of than anybody else, in spite of their not needing it much.

All the time I have had in Puno I have spent in

Digitized by Google Original from UNIVERSITY OF MICHIGAN

dancing attendance on people who had collections of antiquities, and I am sorry to say with no success. I never saw such a set of people as the Peruvians are. They themselves don't care a fig for anything they have; they have old crockery, ornaments, mummies, clothes of the times of the Incas, lying round in all the corners of their establishment, and when you go to see anything you find them everywhere, even under the sofas, chairs, in fact kicking about in all directions, much as George and Max had their play-room while we were repairing the Quincy Street house. Yet the moment you want anything, it is impossible to get it either given to you or to buy it. It at once becomes immensely valuable in their eyes, and just when you think you have closed a good bargain, off they go to consult their father, or aunt, or sister, who are part owners, and when they return nothing more can be done, and all the progress you have made is in vain, and you must start fresh.

With our habit of saying yes or no and being able to make up our mind one way or another, such a course of vacillation is extremely aggravating, and I must say I am heartily sick of it. Yet it is the only way to obtain anything in this benighted country. Time evidently is not money in this place, or anywhere else in South America. I spent all one day at the coal mines of the owner of Inca antiquities, hoping to get him good-humoured, and while at the mine he promised all sorts of things, but now that he has got of me what he wanted he is not so anxious to fulfill his promises; in fact if the Peruvians kept all their promises they would be the most generous people in the world.

The bareness of the respectable houses is something astonishing, no chairs, no tables, nothing of what we deem

Digitized by Google Original from UNIVERSITY OF MICHIGAN

to be indispensable, and as for the luxuries, even the smallest which are found everywhere in all the decent homes, there is no trace of them. As to their manners and customs, they will not bear description, and as long as the present style continues there is but little hope of being able to introduce anything like reform. Imagine at a dinner party eating your pie with a knife (in a crack house of Puno), and at the same time, although there were napkins, the majority of the people present, all high functionaries, wiped their mouths and hands on the edge of the tablecloth, including the lady of the house! The women, I must say, all stand on a very much lower level than the men. They know absolutely nothing and are dirty, slovenly, in fact seem to be a sort of head servant in their husbands' houses.

I found when I got to Puno that I must give up my proposed visit to Cuzco; it is too early in the season and the roads, to judge from a few which I have passed over, are bad even for Peru, which is saying a good deal. I am very sorry for this, as my trip on Lake Titicaca has excited my appetite very much regarding antiquities. In fact this trip seems to have opened my eyes in a great many directions, and I have learned a great deal of specialties which formerly interested me but little.

I commenced this letter at Puno, but I am now writing from a place called Juli, about sixty miles south of Puno on the Lake Shore; here I met Garman and his schooner quietly at anchor. He has done very well in way of collections, and if I can only get all this safely home I shall have plenty to occupy me in writing up this trip. I am on board the Yavari, a small steamer of about eighty tons, which goes entirely round the Lake and arms and I have the steamer literally at my disposal,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

to stop her on her journey whenever I wish to sound and make deep water observations. I shall devote myself specially to this, and hope with what Garman has done to have a good idea of the physical geography of the Lake.

The Captain could not be more devoted; he was educated in England, speaks English well, and is a striking contrast to Peruvians, active, prompt, intelligent, and devoted to his business. He also gave up to me his cabin and turned out the purser; otherwise I should have had a pretty uncomfortable time, but as it is I am very well off. The food is pretty bad, but I manage when coming in very hungry to make an excellent meal. I hope to be able, if the weather allows me, to go to Tiaguanaco, where there are some magnificent ruins, for what I have seen at Titicaca does not impress me greatly thus far in favor of Inca architecture. I fear Squier and others have drawn a very long bow, or had taken a little too much of the native "Italia."

A part of my present trip goes over the same ground as the last one I made, but it could not be helped, and as I have now from Garman all the sounding apparatus, I shall not be sorry to go over the whole ground again. Juli, where I met Garman, is a very prettily situated place, in fact all the little towns on the Lake Shore could not be in more advantageous positions, a little ways above the Lake with a sloping green to the shore, and generally on each side quite high hills flanking a lower hill in the rear.

Near the southern end of the lake is the Cathedral of Copacabana, with its famous image of the Virgin. This shrine is the resort of pilgrims from almost every

Digitized by Google Original from UNIVERSITY OF MICHIGAN

part of South America. In order to obtain a good view of the image, weighed down with a king's ransom of jewels, Agassiz paid for a high mass, and he and the captain, both holding a huge lighted candle in each hand, were allowed to crawl up to the figure on their knees!

At the northern extremity of the peninsula of Copacabana, lies the sacred island of Titicaca, the Mecca of the ancient Incas. A narrow strait separates the island from the mainland, across which the Incas were compelled to pass on their pilgrimage to the sacred shrine. Here Agassiz used his dredging apparatus for the novel purpose of trying to scrape up any antiquities which might have been dropped overboard. Quantities of mud, however, soon clogged the dredge and rendered further exploration useless.

TO WOLCOTT GIBBS

AREQUIPA, March 3, 1875.

I have just returned from a three weeks trip to Lake Titicaca and have been quite successful. I chartered a small schooner of about thirty tons and sent my assistant, Garman, round the Lake to stop at all ports and dredge and sound wherever practicable. He was gone about five weeks and succeeded in getting together an excellent collection of the Birds of the department found along the Lake shores. He made some thirty soundings at different points and dredged up quite a collection of Crustacea, Mollusca, etc., from the deep water of the Lake, making at the same time a collection of the Fishes found in the Lake. Only three species were known thus far. I think from the Lake Mr. Garman added three more and this number (six) represents

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

the total number of species, which is remarkably small for such a large body of water. He also made an excellent collection of Reptiles, found a gigantic Frog, dredged from the shores. Frogs and Toads are most abundant in the region of the Lake.

I myself made two trips on the Lake in the small steamers which are run by the Peruvian Government between Peru and Bolivia. During the trips I devoted myself mainly to sounding and to collecting what few antiquities I could pick up at the different ports. The Lake is found extremely deep; the northeastern shore end is in some places no less than 151 fathoms deep; and in a section from Vilquechico to Puno the depth of the Lake passed gradually from 135 fathoms to about 111 fathoms within a short distance of the entrance to Puno Bay; the lake bottom seems made up of a series of long flat plains nearly horizontal and run parallel running northwesterly, separated by the anticlinals which form the ranges of plains found in the lake.

But a very remarkable feature of the Lake is the temperature of the water; the surface water has an average temperature of about 57°, while the bottom has an invariable temperature at this season of no less than 55° to 58°; even at 151 fathoms the deep-sea thermometer stood at 55°! which for the greater part of the time was *greater* than the temperature of the air. This condition of things is very readily explained from the powerful action of the nearly vertical sun at this season. The water of course absorbing the heat, retaining it, and becoming an immense caldron of warm water in spite of the large amount of cold water which at this season of the year (the rainy season) pours down from the rivers at the northern end of the Lake. As in their

Digitized by Google Original from UNIVERSITY OF MICHIGAN

winter season the sun retains a great altitude, the latitude being 16° S., it is probable that even in winter the temperature of the water remains quite high. I left with the Captain of one of the steamers my deep-sea thermometer and sounding line, so that he will be able to carry on the observations at all months of the year.

Nearly the whole bottom of the Lake is covered by a thick bed of fine black silt like an impalpable powder, which of course kills all vegetation, and this in addition to the high temperature of the water are the causes, undoubtedly, of the small number of Fishes found in the Lake and the scarcity of animal life on its bottom, there being but few spots where the bottom was rocky or sandy or gravelly and fitted to support animal life. Of course there are extensive shoals varying from one to three fathoms in depths where the Lake bottom is covered with tall reeds and with weeds, but the latter never reach a greater depth than seventeen fathoms, eight to ten fathoms being the usual limit of the aquatic plants.

The temperature of the air is most variable at this height (12,560 feet); the sun is extremely powerful, but a passing cloud is sufficient to chill the atmosphere, and in a few minutes the thermometer drops from say 68° in the sun to 50°, or even 45° in the shade when raining, as it almost always is in the morning and evening. At this time, the temperature remains much below 50° (all my figures are Fahrenheit). It will be very interesting in the winter months to have a series of observations made, as during that time the sun shines very brightly all day (the dry season) and from middle of April to December there are but few cloudy days.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

The Lake never freezes, although plenty of ice is formed along the shores, which invariably disappears before the sun gets high. It is then hot in the day, while the sun shines, but quite cold at night as soon as the sun has set, cold enough to freeze hard. I expect to leave for home by the steamer of March 14 for Callao and to reach New York about the tenth of April.

The foregoing letter explains only in part why Agassiz brought back from Lake Titicaca more alcohol than specimens. For the exploration of this elevated sheet of water disclosed a condition of things similar to the marine life of the Arctic regions — a great abundance of specimens, with a comparatively small number of species. As in the case of many other isolated sheets of water, its few species were peculiar to the lake. The collections brought out the curious fact that, whereas the Mollusca were species of fresh-water genera, the Crustacea, on the other hand, belonged, with the exception of one species, to the Orchestiidæ, forms which hitherto had not been reported from strictly fresh water. But his work in another field, to which he now first turned his attention, yielded a rich harvest of Peruvian mummies, Inca relics, and implements of the modern Indians. These he gave to the Peabody Museum.[1]

Twenty years later, when visiting the zoölogical stations of Europe, and looking up his scientific friends, he was amused to find at the Ethnographical Museum, in Berlin, collections that had been offered him at Lake Titicaca at a fabulous price, and had been purchased lately for a song, owing to the death of the owners. He dis-

[1] The south wing of the University Museum.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

covered that the curator knew all about the antiquities he had gathered in South America, and afterward in Yucatan and the Hawaiian Islands, and had used this as a means to force the German government to send out collectors, lest a private individual should carry all such objects to Cambridge.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

CHAPTER VII

THE NEWPORT LABORATORY

From personal knowledge of the Atlantic coast between Eastport and the Tortugas, Agassiz had reached the conclusion that no place offered better facilities for the summer study of marine animals than the vicinity of Newport. This led him, in the fall of 1874, to join Mr. Shaw in buying the southwest extremity of the Island of Rhode Island a little peninsula of about thirty acres, known, from the remains of some old earthworks, as "Castle Hill." The place marks the eastern entrance to Narragansett Bay, and commands a beautiful view of the ocean and sound. Here during the winter of 1874–75, the brothers-in-law each built a house. Agassiz moved into his in 1875, and it became his summer home for the rest of his life. As Mrs. Louis Agassiz continued to pass her summers at Nahant, Mrs. Russell, Agassiz's mother-in-law, presided over his Newport establishment until her death in 1888. Mr. Shaw never lived in his house, which Agassiz bought some years later, when it promptly burnt down.

The moving to Newport in the spring and back to Cambridge in the fall was accomplished, during his visits to Calumet, by his servants, who worshiped him, and never thought of leaving. Since he never would discharge an old employee, an unusual number were pensioned at his death. To everybody about him of the humbler sort he was exceptionally considerate, often

Digitized by Google Original from UNIVERSITY OF MICHIGAN

shutting his eyes to petty impositions that he would not have tolerated from his associates.

Although "Castle Hill" was often filled with his sons' friends, he lived very quietly there for many summers, mingling little with the Newport life. He, however, saw something of Professor Cooke and Professor Gibbs, who were settled at Newport, and occasionally entertained some distinguished man of science from the Old World. But as a rule he allowed nothing to interfere with his work, and limited his recreation to a row in the bay with one of his boys, or an afternoon's ride on horseback. In later years the automobiles sadly interfered with his riding, and this probably had some bearing on his great dislike of them. Not long after the introduction of those conveyances, the *beau monde* of Newport arranged for a great race around the ocean drive, the only access to his place. Notwithstanding the objections of Agassiz and other abutters, after an uncivil war, the city of Newport consented to close the road for the afternoon, to the delight of the promoters and the apparent discomfort of their opponents. At the last moment, however, Agassiz completely turned the tables by getting an injunction and preventing the race. This led a waggish friend to insert a notice in the papers denying the report that Mr. Agassiz contemplated making his next trip to Calumet in an automobile.

His dislike of these machines he retained to the end of his life; only a few years before his death he came into his house in Cambridge, delighted with an occurrence he had just seen in Boston. It appeared that on a corner where people were accustomed to wait for the electric cars, an automobile, with its owner lolling in the back seat, had pushed through the crowd and

Digitized by Google Original from UNIVERSITY OF MICHIGAN

knocked down a woman. Her escort jumped on to the front seat, and Agassiz said it had given him the greatest delight to see what a thorough pummeling he gave the chauffeur.

"But why," asked his listener, "did n't the owner come to his chauffeur's assistance?"

"Oh!" exclaimed Agassiz, "I was holding him."

Nothing would induce him to get into an automobile in the East, but after Calumet acquired her subsidiary companies, the ground to be covered became so great that he found it convenient to employ one during his inspections, a fact that found its way only gradually to his friends in the East. One day, shortly after his first use of them, the newly appointed manager was driving him about. As he knew Agassiz's opinion of automobiles, the younger man felt extremely nervous; but as they were pressed for time he was obliged to run fast; and somehow he managed to run over a dog. "Now," thought he, "that settles me." But to his intense surprise, Agassiz looked back and remarked sharply, "Why did n't that d—— dog keep out of the way!"

In Newport one room of the house was fitted as a laboratory. In 1877, Agassiz replaced this by a very complete little research laboratory, overhanging the creek on his place. The vine-covered building suggests the châlets of his native land. It was about twenty-five by forty-five feet, to which a wing was afterward added for Agassiz's private use. The main structure was fitted for some dozen advanced students. The north side and east end were studded with windows. At each of these stood a table for a microscope, which rested on an independent brick pier; thus allowing any one to walk about without jarring the instruments. On the south side were shelves crowded

Digitized by Google Original from UNIVERSITY OF MICHIGAN

with reference books, cupboards for glassware, and a large blackboard; while the other end was occupied by a huge open fireplace. Down the centre of the room ran a double row of tiled tables. Clear salt water, pumped from a windmill on the point, was piped to each table. To this a system of slightly compressed air was afterward added. For Agassiz soon found that the best and most convenient way of keeping specimens alive was to keep the water aërated, by allowing a small jet of air to bubble up through the glass jars containing them. By this method it was only necessary to renew the water occasionally.

A few students were made welcome here for over twenty years. These were supposed to be capable of laying out and pursuing their own course of study. They were placed in nominal charge of one of the older men, and Agassiz's instruction was limited to an occasional remark, or bit of advice. Many biologists, since famous, have ridden in the omnibus which used to ply each morning from Newport to the laboratory with a party of eager young naturalists. In the creek near by lay a launch, much in request for collecting specimens. The students often wondered why the boat always disappeared from her moorings during the latter part of June, — an absence which the following incident explains.

While passing through San Francisco, to join one of his Pacific explorations, Agassiz was given a dinner by the Harvard Club. When called on to say a few words, he dwelt on the undue importance given to athletics at Harvard, and the responsibility of her graduates for such a misfortune. As he finished, a crack oar of a famous crew, some twenty years after Agassiz's day, rose from

Digitized by Google Original from UNIVERSITY OF MICHIGAN

the other end of the table and asked to add a postscript. Steam launches, he said, were uncommon in the late seventies, and Mr. Agassiz was one of the few graduates who had one, which he used in connection with his scientific work. This launch was regularly placed at the disposal of the crew when it went to New London for a final preparation for the Yale race. Its absence from Newport must have sadly interfered with the work there, especially as, when the boat went out to follow the shell, the figure in the bow of the launch, coaching the crew, often bore a strange resemblance to the guest of the evening.

The laboratory was closed to students in 1898, for Agassiz then found himself forced to devote most of his time during the summer to the preparation of the reports of his various expeditions, to the publication of the reports of the specialists who were working on his collections, and his correspondence with them. But press of work was not the only reason that kept the laboratory closed; the lukewarm interest that the University authorities showed toward a proposed project of enlarging it, undoubtedly influenced him. In writing of the incident some years later, he says: —

"On unfolding my plans they were received with such cold water that I then and there abandoned the whole scheme.

"I closed the Laboratory at Newport, which I planned to be a substitute for the Anderson School of Natural History, with less regret, as since the opening of that Laboratory the Fish Commission had established itself at Wood's Hole, where the Marine Biological Association had also built a Laboratory, and many of the larger

Digitized by Google Original from UNIVERSITY OF MICHIGAN

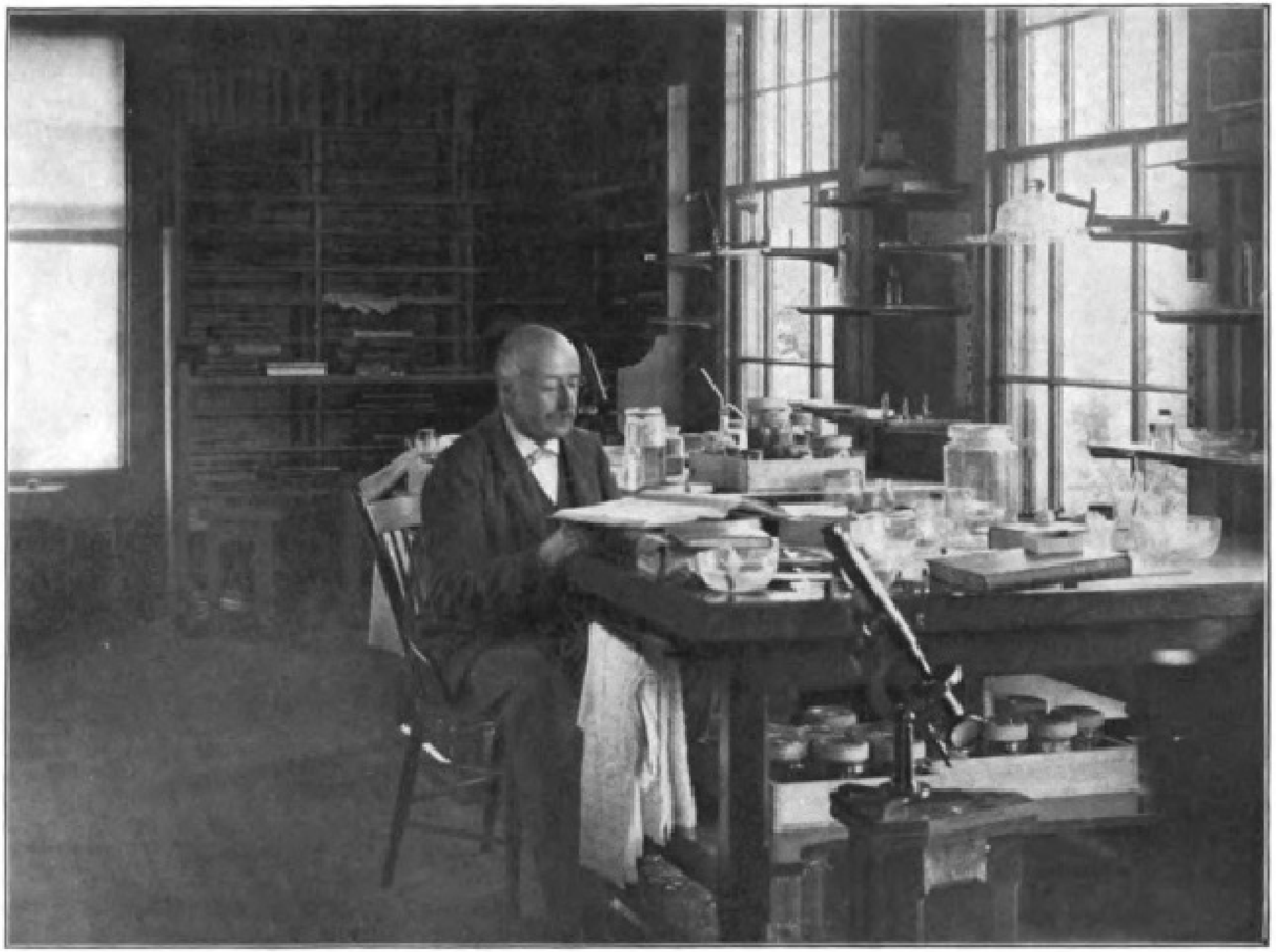
Universities had also erected their own Laboratories at the seashore. There were thus more than sufficient facilities to replace the loss at Newport.

"This is one of the examples of the indifferent support I received from the highest officials of Harvard College. I know of no University which would not have met half-way the offers I made."

Before settling at Newport, Agassiz had again taken up his studies in the embryology of Echinoderms. Some experiments in artificial fertilization resulted in his succeeding in crossing two of the more common species of starfish found on the northern coast of Massachusetts. This led him to believe that the well-known difficulty in distinguishing the species of Asteracanthion might be a question of hybridism.

At first much of his work at Newport was devoted to the study of the embryology and early development of some of the fishes of the New England coast. His investigations of young flounders have a special general interest. In its first stages the young of the flounder is symmetrical and swims about in the manner of other fish, but at an early age it lies down on its side, and the lower eye travels over to the upper side, through the head in some species, and in others by a sort of sliding around the head. There are right-sided and left-sided species, and it is curious to note that nature does not furnish the individual with an unfailing instinct as to which side it is fitting to lie down on. In one case, out of fifteen individuals, no less than eight lay down on the wrong side, and perished of what appeared to be a sort of brain trouble. He also noticed the extraordinary power of protective mimicry in these animals. Provided

Digitized by Google Original from UNIVERSITY OF MICHIGAN



IN THE NEWPORT LABORATORY

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

with black, yellow, and red pigment cells, which they expand at will, they are able, in about ten minutes, to assume the appearance of the bottom on which they find themselves. From his experiments, Agassiz was inclined to believe that these fish have the power to distinguish certain colors from others. This question of the development of a sense of color so early in the Vertebrate series leads him to consider the development of this sense in man: —

"It certainly seems," he writes, "from a physiological point of view, very hazardous to infer, as has been frequently done on philological grounds, the gradual development of the sense of color in early races of mankind, from the color descriptions of Homer and early Greek writers. Certainly, the facility for painting and coloring noticeable in the pottery of the uncivilized races of the world seems unfavorable to this theory."

Wyville Thomson, writing from the Straits of Magellan, had asked Agassiz to come over to Edinburgh in August, 1876, and help him sort the collections of the Challenger, and distribute them to the different specialists selected to work them up. Agassiz was of course eager to accept the opportunity of studying such an unrivalled collection. This visit was delayed, owing to the illness of his sister, but late in the year, and during the first weeks of 1877, he spent two months with Thomson at Edinburgh. Of this visit Sir John Murray says: —

"He would not at that time attend any social functions. Every day from early morning till as long as day-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

light lasted, he assisted me in opening boxes and bottles and in separating out the various groups of marine organisms, especially selecting the Echini which he was to take to America, having consented to describe this group of organisms for the Report on the Scientific Results of the Expedition. While this work was going on we had abundant opportunity for discussing the work and results of the expedition and every aspect of the new science of the sea. I was relatively young, and often recounted to him the comic and other incidents of the voyage, and he would smile and seem amused. His attitude was, however, in striking contrast to the boisterous merriment of Haeckel when engaged with me in the same place and in similar occupations."

Agassiz's influence was no small factor in determining Thomson to distribute the work on the Challenger collections among the best specialists, irrespective of their nationality. This not unnaturally created a storm at the British Museum. Agassiz's own work on the Challenger Echini was much delayed owing to his expeditions on the Blake, which will be spoken of later.

TO SIR JOHN MURRAY[1]

NEWPORT, July 1, 1879.

I was extremely sorry to hear of Sir Wyville's illness from your letter of June 16th just received. I had not heard anything about it. I trust most sincerely he will recover completely with the rest in prospect. He had

[1] He was one of the naturalists on the Challenger, and after the death of Thomson completed the publication of the reports of the expedition. In March, 1911, at the request of the Corporation of Harvard, he delivered a memorial address to Agassiz in Sanders Theatre at Cambridge.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

written me some time ago saying he needed rest and proposing to come over here and take it. If he still feels inclined to do so, I am at his disposal here until September 1, and he can be as quiet at Newport where I am, as if he were fifty miles from any one, and I will keep everything and everybody away from him. September 1, I expect to go to Europe to put my eldest boy in a German family in Berlin, to remain there some time. I shall simply take a flyer over and return at once, and if I don't see Sir Wyville over here shall hope to see him, if only for a moment, before I sail back for United States.

I sent to you a week ago a lot of proofs of plates of my work on Echini. I have never heard that my first invoice of plates, 3 boxes (28 plates, 750 copies) reached you safely.

I am greatly in hopes of finishing my plates of Echini this year, and to get the text so far advanced as to leave me but little to do when I return from my winter's absence. I hope you will get off to Indian Ocean. You ought to get some good things there. I feel somewhat overwhelmed with work and material from the West Indies and look forward with pleasure to completing the Challenger Echini. My preliminary report is in hands of binder, and I ought to send some copies to Edinburgh next week.

Shortly after his return from Europe, he was able to send the manuscript of his Challenger Echini to Thomson; this seems to have been a great relief to him; indeed, he appears to have regarded sea-urchins at this time, much as Darwin did barnacles, for he writes: "I felt when I got through that I never wanted to see

Digitized by Google Original from UNIVERSITY OF MICHIGAN

another sea-urchin, and hoped they would gradually become extinct. Let me know of the safe arrival of the manuscript, for if anything happens to that I shall lose the little hair I have left."

TO SIR JOHN MURRAY

CAMBRIDGE, MASS., Nov. 14, 1880.

I am very glad to hear that all the Challenger plunder came safely to hand and that I am no longer responsible for it. I see my friend —— continues to hammer at the Echini and to twist things to suit himself. I have had the only say I mean to indulge in, but it is very evident he will continue to lie, to put it in a mild form, till doomsday. I notice also he has launched out in malformations, and evidently thinks I am a d—— f—— for not having made use of the Echini to write a paper on that. There will be many points I have not touched which he will gloat over. Let him growl if he likes it.

You will see by last Museum Report that we are making considerable progress, and if copper holds out I will, in the course of a few years, have a model Museum to show you when you come. Dawkins has been lecturing here for some time and has been, I should judge from what I hear, quite successful and well received. Remember me to Thomson.

TO SIR WYVILLE THOMSON

CAMBRIDGE, MASS., Jan. 25, 1881.

I have your note of January 10. I write to tell you that the proof you speak of (the Introduction which you wish me to read over again) has not yet arrived. I have the other proof to pp. 200, which I am now reading. I

Digitized by Google Original from UNIVERSITY OF MICHIGAN

shall of course read the Introduction over very gladly again, as I had already discovered a few changes which had escaped me. I am ever so much obliged to you for all your trouble in this matter of proof. The Introduction I suppose I ought to have spun out at greater length, but it contains the essence of all I wanted to say, which makes it pretty hard reading for any one who has not a very extended knowledge of Echini. I hope before this [reaches you] the proofs will turn up, with your corrections and changes, and that there will not be any delay on that score. I shall be compelled to go off during March for a little while. The Doctor will not let me stay. I am here against his express orders, but I can't get off, as my sister is ill and mother is with her, so I have no one to leave with my boys, and must grin and bear it.

Although deep in the distribution of his Blake collections, and in the work on the Challenger Echini, Agassiz was, as usual, active in increasing from all sources the collections of the Museum.

TO WILLIAM SILLERN

CAMBRIDGE, April 9, 1879.

There is no set of chaps so unblushing as naturalists; they are always wanting something that the other party don't care a straw about. Nevertheless I am going to ask you to put yourself out for me and get me one of the large Cuttle Fish which used to be so common in San Francisco market when I was there. The room in the Museum devoted to that beast and its nearest allies is nearly ready, and I am greatly in want of a large Cuttle Fish to scare small boys and frighten women. I don't want him too big, say not more than five feet

Digitized by Google Original from UNIVERSITY OF MICHIGAN

when fully expanded. The Chinamen used to get them very often, of all sizes, in their nets and then cut them up and sell them to unsuspecting Frenchmen who mistook the species for frogs' legs. Now if Ralston has left any Chinamen in San Francisco, can you speak to a promising specimen of Mongolian and ask him to cling to a good specimen, if the species does not freeze to him. Then by a judicious cutting open of his lower side, so as to let alcohol into his insides, put him into a keg of alcohol and ship him, *via* Panama, to your humble servant, who will receive him with open arms.

Should you be in want of any beast from this side, call on me. I hope one of these days to get over to San Francisco and renew my pleasant associations of old days.

In August, 1880, Agassiz delivered an address before the American Association for the Advancement of Science, using his knowledge of the Echini to show the extreme difficulty, if not impossibility, of ever obtaining a complete record of the development of even a single group. In acknowledging the receipt of a reprint, Darwin writes: —

"I read your address with much interest. However true your remarks on the genealogies of the several groups may be, I hope and believe that you have overestimated the difficulties to be encountered in the future. A few days after reading your address I interpreted to myself your remarks on one point (I hope in some degree correctly) in the following fashion: —

"'Any character of an ancient generation or intermediate form may, and often does *re*appear in its de-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

scendants after countless generations, and this explains the extraordinary complicated affinities of existing groups.'

"This idea seems to me to throw a flood of light on the lines, sometimes used to represent affinities, which radiate in all directions often to very distant sub-groups — a difficulty which has haunted me for half a century. A strong case could be made out in favor of believing in such reversion or atavism after immense intervals of time. I wish the idea had been put into my head in old days, for I shall never again write on difficult subjects."

Agassiz's attitude about this time toward evolution is perhaps best shown in the following extracts from a letter to his uncle Alex Braun: —

"I must frankly acknowledge that my leaning is towards evolution with general sense, but as to swallowing all that the Darwinists and extreme Haeckelists wish us to take down, I have not the least idea of doing that. I don't know that my position is of any particular value, but I am claimed equally by the extreme evolutionist and the most ardent Cuvierian, so that I must have expressed myself much like the Delphian oracles to suit all parties so well."

And again in speaking of Karl von Baer: —

"The account he gives and the estimate he makes of his own work is capital, and I hope the whole article will have a wide circulation. It will do much to kill the present mania for extremes, and will I hope lead the younger men who are indulging in such high flights to

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

put their noses down to the grindstone again and do a little hard work before they finish unravelling the mystery of creation. It is hard work I know to fight against the crowd, and the mania which seems to have seized all the younger workers makes me often doubt the wisdom of saying anything, it all falls so flat; still I know our time will come, and those who have kept cool, and continued to work quietly during this time of transition, will find themselves some day just so much ahead of their metaphysical opponents, and for that time I am quietly waiting."

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

CHAPTER VIII

1877–1880

THREE CRUISES OF THE BLAKE

Agassiz's interest in oceanographic exploration, which in its broadest aspects was to form the chief interest of his later life, dates from a short voyage, soon after his arrival in the United States, made with his father in a little coast survey vessel. This came near being his last as well as his first probing of the ocean, for after falling down a hatchway he was laid out apparently dead on the sofa in the saloon.

Two Italians, Marsili and Donati, appear to have been the first men to employ a dredge for collecting scientific specimens. About 1750, they used a common oyster dredge in shallow water. In 1779, O. F. Müller, the Danish naturalist, invented a special dredge for scientific work with which he studied the bottom of the sea to a depth of thirty fathoms. Among the pioneers in oceanography may be mentioned Forbes, Torell, the elder and younger Sars, Alphonse Milne Edwards, and in America, Pourtalès.

As a result of deep-sea work in the Ægean in 1841, the brilliant naturalist, Edward Forbes, had propounded the theory that animal life at the bottom of the sea was limited to a depth of three hundred fathoms. This was the generally accepted belief up to the late sixties, though a few naturalists, mindful of certain half-forgotten facts, attempted in vain to question the authority

Digitized by Google Original from UNIVERSITY OF MICHIGAN

of the English savant. As early as 1818, for example, Sir John Ross, who was the first person to make satisfactory soundings at considerable depths, had in Baffin's Bay brought up samples of the bottom containing worms from a depth of ten hundred and fifty fathoms, and had found starfish entangled in his line from a depth of eight hundred fathoms. In 1860, the Bulldog had found starfish on its sounding-lines at a depth of twelve hundred and sixty fathoms; and in 1860 and 1861, in repairing old telegraph cables, living animals were found growing on them at a depth of twelve hundred and sixty fathoms and two thousand fathoms, respectively.

Furthermore, while naturalists were discussing the absence of animal life on the floor of the ocean below three hundred fathoms, deep-sea sharks were continually taken at a depth of five hundred fathoms by Portuguese fishermen, and the fact that, on both sides of the Atlantic, fish, which could only subsist on animal life, were caught in deep water, seemed to produce no impression on most scientific men, while the extensive collections of Torell, from depths of over one thousand fathoms, appear to have been completely lost sight of.

In 1867–69 the expeditions of the Corwin and the Bibb under Pourtalès who had followed to America in the wake of the elder Agassiz, disclosed off the Florida coast an abundance of life on the bed of the ocean down to nearly eight hundred fathoms, thus clearly showing that the range of animal life was at all events much deeper than the supporters of Forbes had supposed.

The work of Pourtalès was followed by a series of English expeditions in the Lightning, Porcupine, Val-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

orous, and Shearwater, in joint charge of Thomson, Carpenter, and Jeffreys, and culminated in the famous voyage of the Challenger around the world, with which the name of Sir Wyville Thomson will always be associated.

At this point, when the study of oceanography was still in its infancy, Agassiz took up his active field work in the science. It is natural that he should have been eager to undertake such explorations. For we have seen, in the preceding chapters, with what interest he followed the explorations of Pourtalès and Thomson, assisting in the distribution of their collections, and working up the Echini himself.

His native abilities and his training combined to make him an ideal leader of oceanographic expeditions. Rarely do we find the savant and the man of action combined. Besides his wide knowledge of marine zoölogy, he possessed a natural aptitude, educated in the development of a great mining industry, for managing enterprises and men; while his training as an engineer was invaluable in equipping, handling, and improving the apparatus used on a vessel engaged in the study of the deep sea.

Agassiz shared with several other noted men, who made a business of going down to the sea in ships, the misfortune of being easily seasick. Any one afflicted with the malady can easily imagine what fortitude and enthusiasm it must have required to crawl on deck from a bunk of despondency and pain and lose one's self in the eager examination of the treasures which the dredge had just brought to the surface.

Amidst all the detail that inevitably envelops a scientific voyage, he never lost sight of the broader aspects

Digitized by Google Original from UNIVERSITY OF MICHIGAN

of his work. The goal for which he was constantly headed is revealed in his own words: —

"The field of work opened to naturalists by thalassographic[1] surveys is of the greatest importance. The materials collected throw a flood of light on our knowledge of the conditions of animal life in deep water, and promise the most important general conclusions on terrestrial physics and on geology. Fascinating as has always been the study of marine life, this interest has greatly increased since we have found the means of reaching the abyssal fauna. Light has suddenly been shed on many vexed problems concerning the geographical distribution of animals and plants and their succession in time from former geological periods to the present day. New notions of geological horizons and periods loom up before us, and the problems concerning the formation of continents and oceanic basins now present themselves from a very different standpoint. Our ideas regarding the formation of many marine deposits have been greatly modified, and we are now able to look back into the past history of the world with more confidence than heretofore."

As an example of the broad results of such work, it may be mentioned, for instance, that oceanographers have discovered that the ocean depths are covered with certain deposits; such as the abyssal red clays, formed from the decomposition of matter thrown out by vol-

[1] Agassiz coined and always used the word "thalassography" to denote the study of the ocean. But it never came into general use, partly, perhaps, because of a mistaken impression that θάλασσα referred only to the Mediterranean, and partly because, for once, scientific men seem to have preferred the simpler word "oceanography."

Digitized by Google Original from UNIVERSITY OF MICHIGAN

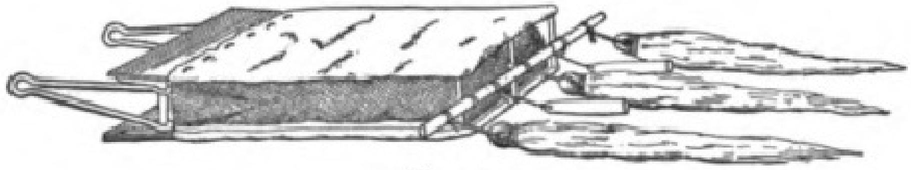
canoes, which has fallen on the surface of the oceans and sunk; and the pteropod and the Globigerina oozes, composed of the accumulation of the shells of small animals living near the surface which have died and fallen to the bottom. Geologists have been unable to point to any rocks anywhere on the earth's surface that could have been formed from such deposits. Hence we seem led to the inevitable conclusion that the beds of the oceans have been such for a considerable period of geological time. So that geologists who have kept in touch with the advances of oceanography are inclined to be conservative in their estimates of the amount of disturbance in the earth's crust under the sea in recent geological times.

In 1877, Agassiz eagerly accepted an invitation from Carlile P. Patterson, superintendent of the United States Coast Survey, to take charge of a series of dredging cruises in the steamer Blake. She was a small schooner-rigged vessel of 350 tons, 140 feet on the water-line, with a beam of 26½ feet and a draught of 11 feet; commanded by Lieutenant-Commander (now Retired Rear-Admiral) C. D. Sigsbee, afterward captain of the ill-fated Maine.

In equipping the Blake, Agassiz found his experience as a mining engineer of the greatest assistance in making many improvements in the apparatus used by his predecessors. In this he was ably assisted by the ingenuity and mechanical skill of Captain Sigsbee. The most important improvement Agassiz introduced was the substitution of wire rope for dredging in place of the hemp rope used in all previous deep-sea expeditions. He also changed the arrangement of the drums and other apparatus used in hoisting.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

The chief appliances used by the oceanographer in collecting specimens are the dredge, the trawl, the tangles, and the tow net. Up to that time the dredge used by the Danish naturalist O. F. Müller, in the eighteenth century, a modification of the old oyster dredge, had undergone but slight modifications. The naturalist's



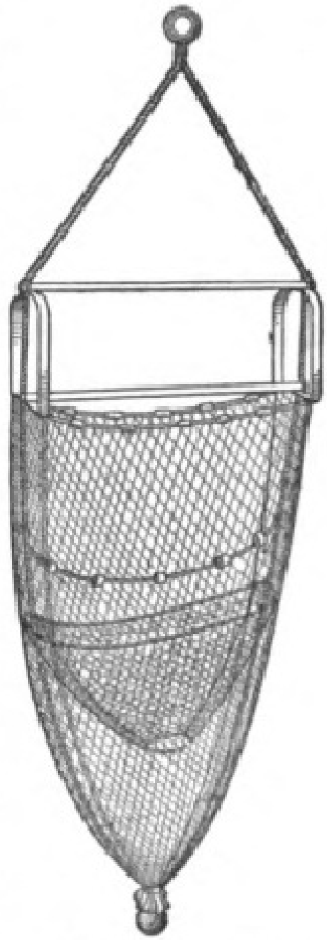
DREDGE

dredge consists of a framework of what would be the edges of a broad shallow box. To one end of the frame, which is considerably heavier, a bag of netting is attached and a heavy canvas is stretched over the frame, leaving the towing end of the dredge open, to which the mouth of the bag is attached. Dredges as then made had beveled edges at the open ends of the frame. Such dredges, when drawn over muddy bottoms, brought up a great amount of mud. To obviate this defect, Agassiz bound stout rope about the forward framework so that the lips should not cut into the mud, and subsequently his dredges were made with flat frames, which completely obviated the defects in the old-fashioned models.

The trawl is by far the most useful instrument in deeper water, where the bottom generally consists of ooze or fine mud. Before Agassiz's day, the form used in deep water was the ordinary beam trawl of fishermen. This consists of a beam on runners, to which is fastened a long V-shaped net. In shallow water this trawl can be so weighted as to fall on the runners, but

Digitized by Google Original from UNIVERSITY OF MICHIGAN

in deeper water it was impossible to prevent its falling on the wrong side, causing much delay and vexation. Agassiz devised a modification of this trawl that worked equally well on whichever side it fell. In order to bring up less mud the length of the net was reduced to fifteen feet and the meshes of the outer net made coarse, while only a small part of the bag was fine enough to allow the mud to accumulate.



Blake Trawl

In writing of the equipment of the Blake, Agassiz says in 1907: "We built what is known as the Blake trawl; all subsequent French, German, Italian, and Danish expeditions have adopted it, as well as the wire dredging rope and the arrangement of the drums, first in use by the Blake."

Tangles consist of a number of rope tails fastened to an iron bar, which is attached to the end of the dredge frame. This, under certain conditions, is a most effective apparatus for collecting, and often brings up a great quantity of specimens tangled in its swabs. The tow net is something like a huge butterfly net, which may be towed at any given depth to collect specimens suspended in the water.

Not the least important piece of apparatus is the sounding machine. It would seem at first glance to be a very simple process to find out the depth of the ocean.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Sounding in a few fathoms with a common lead line is an easy matter; and even down to one hundred fathoms fairly accurate results may be obtained with a hand lead line. Below this, the matter is quite a different question, and when it comes to sounding in depths of several miles the problem is exceedingly difficult.[1] Even at comparatively moderate depths the weight of the rope is so great in relation to the sinker that it becomes impossible to determine when the bottom is reached. Professor John M. Brooke, when a passed-midshipman, devised the first considerable improvement on these antiquated methods. He contrived an apparatus consisting of a cannon ball on a very light line, so constructed that on striking the bottom the weight was disconnected and the line drawn up with only the collecting cup, containing a sample of the bottom. Lord Kelvin, in 1872, invented a sounding machine in which he used a piano-wire line. An improvement on Lord Kelvin's sounding machine, devised by Captain Sigsbee, had already been in use on the Blake for three years.

Agassiz joined the Blake at Havana on December 17, 1877, where he found his assistant, Mr. Garman, who had come down on the boat from New York. A glance at Chart 1,[2] in the pocket in the front cover, will show the lines run on this cruise. It embraced the region to the north and west of the western end of Cuba, the Yucatan Bank, and the districts about Key West and the

[1] The deepest known spot in the ocean, near the Island of Guam, is 5269 fathoms — sixty-six feet less than six miles. If Mount Everest were sunk in this spot its summit would be over two thousand feet under water.

[2] The tracks of the voyages of the Blake are taken from a chart in *Three Cruises of the Blake*, and include some lines of soundings made when Agassiz was not on board.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Tortugas. The expedition terminated in a trip from Tortugas to the mouth of the Mississippi, Agassiz and Mr. Garman leaving the ship at New Orleans about the middle of March, 1878.

In writing from shipboard to Lord Kelvin concerning the working of the new apparatus, Agassiz says:—

"I know you will be interested to hear of the results of the working of the wire for sounding and of the steel rope for dredging. . . . Captain Sigsbee's machine, a modification of yours, worked to a charm; and the time occupied in taking a deep sounding is so small that I hope to see the day when all large passenger steamers will have a wire sounding machine, and we shall hear nothing more of running ashore because no observations could be had a few days before reaching the coast. But of course our deep-sea hydrography must all be done over with wire, for with the rope soundings no accuracy can be obtained; of this we have had several examples during the present cruise while crossing old lines of soundings run in the antiquated method. I could not help contrasting our soundings—losing a fifty-pound shot by the detacher and bringing up samples of the bottom in so short a time as sometimes twenty seconds for a hundred fathoms! with those of Challenger expending three to four hundred pounds at each cast, and occupying at least six to eight times the length of time in bringing up their cup and thermometers. We could always detect instantly the moment the shot struck the ground, which is more, as you well know, than can be done by the rope and weights in deep water. . . .

"The steel rope we used in dredging has also proved a great success; in fact I do not see how with a small

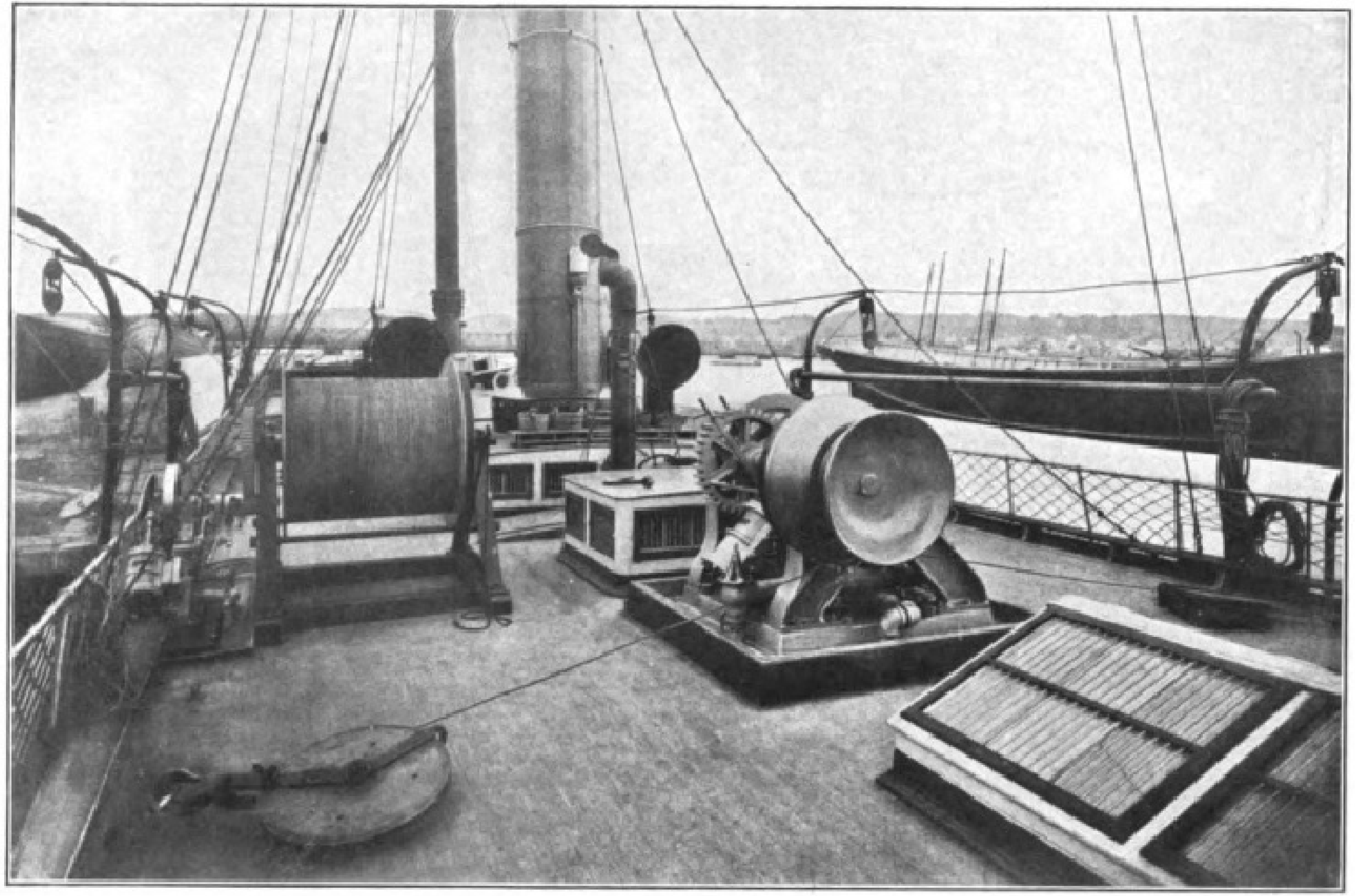
Digitized by Google Original from UNIVERSITY OF MICHIGAN

vessel like the Blake (350 tons), I could have undertaken deep-sea work continuously, and been able to stow away the length of 2½ and 3 inch rope needed for my work. In place of having decks entirely choked with rope, we had only two reels of steel rope 1⅛ inches in circumference, each of 3000 fathoms, the whole space occupied being less than 5×5×4 feet for cast reel; the reels themselves were used by means of friction brake to lower the dredge and trawls with, and we hoisted up by an intermediate donkey engine. Now in dredging, we gained immensely again in time, the speed of lowering the dredge and trawls and bringing them up again being fully as great as that attained in hoisting from stopes in mines. In fact it was my experience with mining and use of steel ropes which first suggested to me the idea of using it for dredging. We have thus far made no less than over 50 casts of dredge and trawl from 300 fathoms to 1920 fathoms, and have experienced no trouble of any kind and thus far have lost only 200 fathoms[1] of steel rope! although we have lost plenty of dredges and trawls. The strength of this steel rope was 8600 pounds breaking strain. The greater weight gave us the great advantage of not being obliged to send weights down to act as fulcrums[2] — a great saving of time. Now in Challenger in deep water the best part of a day was usually occupied in making one haul in over 1500 fathoms.

[1] This was done at the first cast, and was the only rope lost on this cruise. The amount of rope lost on the other cruises was trifling, and at the end of three years most of the rope was still perfectly serviceable. On the cruise of the Challenger over fifty-eight miles of hemp rope was lost or worn out.

[2] With hemp rope, in order to sink the dredge, not only did it have to be weighted, but it was also necessary to attach heavy weights on the rope some distance ahead of the dredge.

Digitized by Google Original from UNIVERSITY OF MICHIGAN



THE DECK OF THE BLAKE

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

"With steel rope, one haul in 804 fathoms, the dredge being down at bottom 25 minutes, occupied exactly 1 hour 23 minutes from time it left the ship's side till it was on deck again. This speed does not appear to have injured contents of dredge in any way, specimens coming up in excellent condition. Of course what we have gained by this method of dredging will be apparent at once.

"I thought that these results would be interesting to you and I think we shall see the day when steel rope will be exclusively used in all this sort of work. Experienced little trouble from kinking by keeping line well stretched and not allowing any slack to fall on ground."

The cruise was marred by a most annoying accident, of which he writes to Sir Wyville Thomson: —

"You may have seen from the papers that we ran aground at Bahia Honda (Cuba), in charge of a Spanish pilot, and my private opinion is that it was a put up job, for ever since we have had anything to do with the noble Dagos, as we call them, it has been one series of obstacles and red tape, but you know the cubs and my writing on the subject only drives me mad. I had, however, the satisfaction at Havana, on leaving, to express my mind freely to the Spanish Admiral in command, and to thank him in my best Spanish for his duplicity towards us ever since we landed on his infernal island. I have of course known people to lie, but to go out of your way, as these people have done, in order to keep us aground, was more than I could stand. It was only after seeing that we got no help from Havana, in spite of telegraphic promises, that I went overland to Havana —

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

and what a ride! I had to go up to waist in mud, and almost forcibly secured what we wanted from the Navy Yard and Arsenal, hired a tug, and in two days we got our vessel off; not badly damaged, but still we have lost three weeks."

During this cruise he found that the fauna of the Yucatan Bank was identical with that of the Florida Bank, which was already well known from the shallow water on the Florida side. Along the Cuban coast, the dredge brought up quantities of silicious sponges, and many of the corals collected by Pourtalès to the south of the Florida reefs. Though Agassiz got many stems of Pentacrinus and portions of the arms, he was not fortunate enough to obtain a single entire specimen of that famous sea lily, of which there were probably not more than a couple of dozen specimens in collections at the time. He discovered, as the Challenger had, an abundance of life on deep bottoms that were covered with Globigerina ooze. He also found that most of his deep-water species were closely allied to those brought up from great depths by that vessel. Often when examining the contents of the trawl he would recognize old Challenger friends, including many of the curious deep-sea fishes, — forms he had become acquainted with while examining the Challenger collections with Sir Wyville Thomson the previous winter. One especially interesting species resembled a huge tadpole with a gigantic cartilaginous round head without eyes. Among the others were a couple of species with elongated flattened heads, diminutive eyes, and gigantic filaments fully as long as the body, which probably have the function of organs of touch.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

On the line from Tortugas to the Yucatan Bank, he first obtained magnificent specimens of a bright scarlet Gnathophausia, together with some gorgeously colored eyeless Macrurans. Here he also secured several species of remarkable deep-sea Holothurians, similar to those obtained by the Challenger off the coast of Portugal; these species appear like large masses of jelly brilliantly striped with deep crimson bands, with the mouth, which forms a kind of foot, placed on the lower side.

On one occasion, during a short calm, he had an excellent opportunity of seeing a number of Globigerinæ and Orbiculinæ alive. They were swarming near the surface, the nucleus of a brilliant vermilion, in company with a host of Diphyes, pteropods, heteropods, masses of gulfweed, and the accompanying countless larvæ of Crustacea, mollusks, and fishes which inhabit this weed.

On the last series of lines from Tortugas to the Mississippi, Agassiz found that the deep-water fauna on the western slope of the Florida Bank corresponds with that of the eastern slope of the Bank of Yucatan, and that this deep-water fauna extends over the bottom of the Gulf of Mexico as far as the Mississippi slope, where, owing to the presence of dark, rich mud, the fauna materially changes its character. Here they obtained an interesting collection of fishes, worms, mollusks, ophiurans, and sea-urchins.

When Agassiz left the Blake at New Orleans he felt it must have been a great relief to the officers, more particularly to the executive officer, Lieutenant Ackley, to be able to get the Blake into an orderly condition again. For during the whole period that Agassiz spent on board, no routine was allowed to interfere with his

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

work, and dredging is not a cleanly process; the quantities of material brought up from the bottom often made the bow of the Blake look like a mud scow.

Leaving New Orleans, the Blake returned to Key West to continue her regular work of sounding. But before sending ashore the dredging apparatus, Captain Sigsbee ran over to Havana in the hope of supplementing the exceedingly rich collections with a few specimens of Pentacrinus from one of the localities where they had found innumerable fragments of stems. In this he was most successful, for at a point on the coast, about one and a half miles to the eastward of Morro, he succeeded in bringing up no fewer than twenty perfect specimens.

In the fall the Blake was again placed at Agassiz's disposal. He joined the ship at Washington on November 27, 1878, once more taking Mr. Garman as his assistant. On this voyage the vessel was in command of Commander J. R. Bartlett, U.S.N., though there were still on board a majority of the officers who had been so efficient in the work of the previous season. Proceeding directly to Havana, they made two casts of the dredge on the Pentacrinus ground discovered by Captain Sigsbee, and brought up a few specimens. They then kept along the north shore of Cuba, through the Old Bahama Channel, without stopping to sound or dredge, as this was an old line of Pourtalès years ago in the Bibb. Some hauls were made off Jamaica, whence they were obliged to keep on to the eastward without stopping till off Porto Rico, for the trade winds kick up a considerable sea at this time of year, which endangers the apparatus if used in exposed regions from such a small boat, and makes getting to windward an uncom-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

fortable process. The winter was spent in dredging and sounding among the Windward Islands,[1] chiefly on the lee or Caribbean side, although some work was done to windward of Barbados.

A guest on a much later expedition has reason to believe that the soundings then made on the Blake form the basis of the charts of this region. Hereabout lies the island of Saba, an abrupt volcano rising directly from the sea, whose chief industry is boat-building. Although there is neither a harbor nor any timber on the island, the inhabitants, living mostly within the crater, construct their craft inside its walls, and laboriously drag them to the ocean.

When in 1907, Agassiz was visiting these old haunts in the yacht Virginia, some of the party were anxious to see this curious island. As it was not convenient to land there, the yacht was steered so close along the shore, for a better view of the mountain, that presently there was a note of protest.

"It strikes me," exclaimed an expostulating voice, "that this is a very risky business! How do you know, father, that the chart is to be depended on?"

"Oh! I fancy," said Agassiz quietly, "that the soundings are all right; I made them."

While to leeward of the Caribbean Islands the Blake's dredge brought up large quantities of vegetable matter and land débris from deep water many miles from shore. It was not an uncommon thing to find at a depth of over a thousand fathoms, masses of leaves, pieces of bamboo, of sugar cane, dead land shells, and other land refuse, all of which had undoubtedly sunk after being

[1] Much work, which does not appear on the chart, was done among the islands, often at very considerable distances from the track shown.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

blown out to sea by the prevailing easterly trade winds. The ship frequently encountered masses of vegetation more or less waterlogged and ready to sink. Agassiz imagines how such a deposit might puzzle some future palæontologist who should discover the fossil remains of Crustacea, Annelids, fishes, Echinoderms, sponges, etc., mixed with mango and orange leaves, branches of bamboo, nutmegs, and land shells. He would naturally explain such a condition as representing a shallow estuary surrounded by forests, and yet the deposit might have been made in fifteen hundred fathoms.

While examining the contents of a trawl under a scorching sun, the well-known fact was brought home to Agassiz that the water of the ocean grows colder as one descends, till at great depths, even in the tropics, it approaches the freezing point. For the bottom ooze is intensely cold, and it was a strange sensation, when assorting the catch, while his back was broiling to have his hands nearly frozen from handling the stiff, cold mud.

One hot muggy day it occurred to the thirsty voyagers on the Blake that the cold silent deep might make an excellent refrigerator. Proceeding to apply the results of pure science to practical purposes, they carefully fastened a bottle of champagne to the rope close to the trawl, and sent it down to a depth of twenty-four hundred fathoms. But alas, the result was only encouraging to the friends of total abstinence. It came back cold, it is true, but filled with muddy salt water, which had been forced through the foil and cork, and had replaced the more palatable contents of the bottle.

Of the results of this season's dredging, Agassiz says in a letter to Mr. Patterson: —

Digitized by Google Original from UNIVERSITY OF MICHIGAN

"During this season we occupied no less than 200 stations, and made over 230 hauls from the 100-fathom line to the depth of 2412 fathoms. A few hauls were occasionally made in shallow water, but they formed no part of our regular scheme.

"We rarely got from deep water, say between 1500 and 2400 fathoms, the rich hauls so invariably made in the Gulf from depths of between 1200 and 2000 fathoms. But we found, what was much more important for our success, that the range of the greater number of the deep-sea species extended within very easy dredging limits, and we soon discovered that by dredging mainly between 300 and 1000 fathoms we obtained, not only nearly all the species extending to the 2000-fathom line, but obtained them in considerable numbers. This enabled us, of course, to collect a large amount of material, and the collection of this year's cruise, combined with those of the previous year, added to the older collections made by Count Pourtalès on the Bibb, and to those of the Hassler, make our deep-sea collections but little inferior to those of the Challenger.

"The collection of Ophiurans is perhaps the largest ever made. In some places the bottom must have been paved with them, just as the shallows are sometimes paved with Starfishes and Echini, and many species hitherto considered as extremely rare are found to be really abundant."

TO SIR WYVILLE THOMSON

BARBADOS, March 11, 1879.

Here I am at the end of my work for this season and a very good season it has been. I am surprised to see how many of the Challenger things I have brought up,

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

and I think that I now have the bulk of the groups which you brought home and we shall find that in this region at least the deep-sea things come into quite shallow water, say 300 to 400 fathoms. But of course this will all come out when collections are worked up. Although we got a very much larger number of specimens than last year, the bottom here is not so uniformly rich as in the Gulf of Mexico, where we never made a cast without bringing up a regular museum. Here we often trawled for days, getting little, but when we struck a good spot it produced wonderfully.

I have quite a number of stems of Rhizocrinus Rawsoni, but only got ten heads complete. As for the other Pentacrinus, I have now enough to feel satisfied that there are *two* species and I shall be able to send you both. What do you think of bringing up in one haul *124* of them! I thought I should jump overboard when the tangles came up loaded with them. This brings me to ask you if you want any more for dissection? Ludwig, who wrote the paper on Rhizocrinus, wanted also Pentacrinus just before I left, but as you had them in hand I did not wish to send him any specimens for work till I knew what you were about. Or why don't you ask him to do a lot of this nice microscopic work to help you in your Memoir, so as not to duplicate the papers. Let me know your ideas. I am sorry to say I got no Holopus, though I dredged for two days in all places where I thought they might occur and brought up tons of rocks and broken stones and corals but no Holopus, and none anywhere in Barbados. I leave to-morrow for St. Thomas and hope to be in New York the 26th or 27th of this month, and I shall tackle the Challenger Echini at once and not stop I hope till they

Digitized by Google Original from UNIVERSITY OF MICHIGAN

are back in 1 Park Place. I shall commence shipping you the Plates on my arrival.

TO A. MILNE EDWARDS

CAMBRIDGE, April 9, 1879.

I was delighted to find here your letter of February 5 and the plates of the great Isopod, and the book of Crustacea of Mexico, for which I thank you.

I have again this winter made a superb collection and the Crustacea are well represented. I have again found two specimens of the great Isopod and a gigantic Pycnogonida measuring two feet! I begin to unpack next week and I think that about the end of June I shall be able to send you the collections. I have also a magnificent blind Phoberus as big as a lobster! and a very interesting collection of hermit crabs that occupy fragments of bamboo and other pieces of wood transported to great depths by the trade winds. The collection of Ophiurans is astonishing. The Sponges, Mollusks, Fishes, with the Annelids, Echinoderms and Actiniæ now make a collection but little inferior to that of the Challenger. What do you say to 300 Pentacrinii! two kinds.

I almost forgot to thank you for telling me that I had received from the Academy the Prix "Serres." I feel very much flattered that the Academy have noticed my studies and should have considered them worthy of recognition, which is the more precious to me in that it comes from Paris, whence my father in his day also received the first testimonies of appreciation from his scientific colleagues.

In the summer of 1880 the Blake, with Commander Bartlett again in charge, was for the third time assigned

Digitized by Google Original from UNIVERSITY OF MICHIGAN

to Agassiz. The object of this expedition was to run a series of lines of dredgings from the northeastern edge of George's Shoal to the vicinity of Charleston. In this way a portion of the Atlantic was explored that had been left untouched by the Challenger, and an extension was made into deep water of the ground already occupied in part by the United States Fish Commission.

On the lines off Charleston and in the Gulf Stream Agassiz was much disappointed in the poverty of the fauna; this was probably owing partly to the very gradual slope of the continent toward deep water, and partly to the fact that the strong current of the Gulf Stream sweeps everything off the bottom along its course; so that there is little food for the deep-water animals, and it was only along the edges of the Gulf Stream, where mud and silt accumulated, that he made satisfactory hauls on the southern lines. It was not until he reached the steep slope of the Gulf Stream plateau south of Cape Hatteras, where the bottom is fine mud and Globigerina ooze, that he made a rich harvest again. The richness of the northern hauls, however, amply compensated for those further south, and the expedition was as successful as its predecessors.

Captain Sigsbee accompanied this cruise to superintend the working of an extremely ingenious invention of his, known as the Sigsbee Gravitating Trap.[1] Agassiz and he had often talked together about the best method of determining the depth to which animal life extended below the surface of the ocean. On the first cruise of the Blake they had endeavored, unsuccessfully, to devise a self-closing net. Before the departure of the last cruise Sigsbee contrived an instrument by means of which

[1] Described in *Three Cruises of the Blake*, p. 36, vol. I.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

it was possible to strain a column of water of any height desired, at any given depth. A considerable number of experiments with this apparatus resulted in their being unable to find any life below one hundred fathoms. These investigations led Agassiz to believe that between the fauna living at or comparatively near the surface, and the animals living close to or on the bottom, there was a vast belt of water where practically no life existed.

This theory Agassiz maintained to the end of his life, in opposition to many naturalists, although from his later investigations in other parts of the world he came to the conclusion that the upper zone of life was considerably thicker than he had at first supposed. This question will be referred to again at greater length in a subsequent chapter.

By an arrangement with Sir Wyville Thomson, the collections of the first two cruises of the Blake were sent to the same specialists who had undertaken the study of the material gathered by the Challenger. But much of the plunder dredged on the third cruise was given to the naturalists who were working on the collections gathered along the Atlantic seaboard by the Fish Commission.

During these voyages Agassiz was able to add materially to our knowledge of the warm current, which forces its way between the Straits of Florida and, separated from the coast of America by a cold arctic stream, flows in a northeasterly direction and bathes the coasts of northwestern Europe. Benjamin Franklin appears to have made the first real study of the Gulf Stream, of which he published a chart for the aid of navigators, based on information obtained from Nantucket whalemen. Humboldt and Arago are among those who have

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

been interested in the study of this chief cause of the great difference in the climate of the eastern United States and western Europe.

From such soundings as were already known, his own and those subsequently made by Captain Bartlett, Agassiz concluded that at one time the Caribbean was most probably virtually an arm of the Pacific, or at all events was more closely connected with it than with the Atlantic. This furnishes a ready explanation of the fact that the fauna and flora of the West Indies bear a closer relation to Central and South America than to the southern part of the United States. This view also explains the close similarity of the littoral fauna on both sides of the Isthmus of Panama. The theory was further strengthened by Agassiz's discovery, on subsequent expeditions, that the deep-sea forms on each side of the Isthmus bore a closer relation to each other than did those of the Caribbean Sea to the deep-sea fauna of the Atlantic.

These expeditions also threw much light on the geographical distribution of marine fauna, and the question of the survival of archaic types in the depths of the ocean. Writing of these matters Agassiz says: —

"The depths of the seas seem at first glance the safest of all retreats, — the secret abysses where the survivors of former geological periods would be sure to be found. Yet oceanic dredgings have not brought to light as many of the ancient types as the more enthusiastic dredgers had led us to expect. They have, however, given us a large number of animals living in deep water, where they have been subjected to no violent changes, to which no revolutions of the surface of the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

earth can extend, and where the only changes are probably those of temperature, — animals living now in the depths of the sea, under much the same conditions as those which prevailed during the last days of the Jurassic period.

"The conclusion drawn from these facts by Lovén, Moseley, Perrier, and others is that the abyssal fauna has descended from the littoral and other shallow regions, to be acclimatized at great depths. The conditions of existence becoming more and more constant, or even in the deeper regions perfectly uniform, species of the most varied derivations, when they had once attained a certain zone, could spread everywhere. This explains at once how the deep-water fauna presents a very uniform composition in all regions of the globe, but at the same time includes various species the analogues of which live in the sub-littoral regions of both cold and hot climates, and may have sent an occasional wanderer into deeper waters.

"While the little dredging thus far done in deep water has added to our knowledge a large number of antique types which strongly remind us of Tertiary, Cretaceous, and even of Jurassic forms, we should not forget that such antique types occur everywhere, — in limited numbers, it is true, — both in the shallower regions of the sea and in fresh water. We can only say that in the deep-water fauna a relatively larger number of such antique forms has been found than elsewhere."

The final reports of the collections gathered in these voyages were published by the specialists to whom they were allotted, and appeared from time to time in the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

publications of the Museum. At Agassiz's death, however, one or two of them were still unfinished.

In 1888 he published a semi-popular account of these expeditions, under the title of "Three Cruises of the Blake." With the exception of the narratives of the Challenger Expedition, this was the first publication of the kind. It would be hard to point to anything to-day that gives a better general idea of oceanography. The first volume deals with the general aspects of the subject and the work of the Blake. The second volume is devoted mainly to a description of the various groups collected.

The following paragraphs describing the probable appearance of the depths of the ocean are taken from the first volume.

"The monotony, dreariness, and desolation of the deeper parts of this submarine scenery can scarcely be realized. The most barren terrestrial districts must seem diversified when compared with the vast expanse of ooze which covers the deeper parts of the ocean, — a monotony only relieved by the fall of the dead carcasses of pelagic animals and plants, which slowly find their way from the surface to the bottom, and supply the principal food for the scanty fauna found living there.

"Nearer to the continental masses we find the slopes inhabited by a more abundant and more varied fauna, increasing in variety and numbers according to the amount of food available. But no matter how varied or how abundant life may be, the general aspect of the slopes must be dreary in the extreme, and can only be compared in character to those higher mountain regions where we find occasional fields of wild-flowers and low

Digitized by Google Original from UNIVERSITY OF MICHIGAN

shrubs, or to those zones lying beyond the limits of forests, where vegetation is scanty and poor, and forms but a slight covering to the earth's surface.

"It is true that along the continental slopes, where there is an ample supply of food, we find animal life in great abundance, and there are undoubtedly long stretches of bottom carpeted by the most brilliantly colored animals, packed quite as closely as they are on banks in shallower waters, or near low-water mark. But the scene is much less varied than on land; the absence of plants in deep water makes great diversity of scenery impossible. The place of luxuriant forests with the accompanying underbrush and their inhabitants is only indifferently supplied by large anthozoa and huge cuttlefishes, or nearer in shore, within moderate depths, by sea-weed and the pelagic forests of giant kelp.

"It requires but little imagination to notice the contrasts, as we pass from the shallow littoral regions of the sea, — full of sunlight and movement, and teeming with animal and vegetable life, — into the dimly lighted, but richly populated continental zone; and further to imagine the gradual decrease of the continental fauna, as it fades into the calm, cold, dark, and nearly deserted abyssal regions of the oceanic floors at a distance from the continents. It is like going from the luxuriant vegetation of the tropical shore line — the region of palms, bananas, and mango — into the cooler zone of oaks and pines, until we pass out into the higher levels, with their stunted vegetation and scanty fauna, and finally into the colder climate of the bleak regions of perpetual snow."

Any one who has read that passage will scarcely doubt Agassiz's ability to write with imaginative force.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

There is, however, some truth in the criticism that most of his writing was lacking in a quality that would have added a certain delicacy of touch. But it must be remembered that, with two exceptions, he wrote entirely for the scientific world, and he always felt that the naturalist should be extremely careful that the use of the imagination did not lead to its abuse. This left him little sympathy for those scientific men whose temperamental desire for effect made them lose themselves in that misty region that lies on the borderland between philosophy and science.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

CHAPTER IX

1881–1884

MEXICO AND INDIA

SOME defect in Agassiz's circulation made it very painful, after the days of his youth, for him to pass a winter in New England, and he never did so if he could avoid it; the few he spent in Cambridge always left him much out of condition in the spring. In the eighties, most of his journeys to warmer climates were taken purely in search of health. These travels formed blanks in his scientific life, and make the amount of work he succeeded in accomplishing all the more remarkable. Indeed, much of his research was pursued in a state of health that would have incapacitated any one with a less determined will. It was, however, impossible for such an active mind not to find much of interest, whether in the archæology of Central America and Egypt, the geology of North Africa, the structure of the Hawaiian Islands, or the life of India.

The winter of 1881–82, Agassiz spent in Yucatan and Mexico. A return of his old trouble, brought on by the jolting of the native conveyances of the former country, prevented an extended trip that he had planned with Clarence King to inspect some Mexican mines. King, first Superintendent of the United States Geological Survey, and Director of the famous survey of the fortieth parallel, had apparently a fatal charm for Messrs. Agassiz, Shaw, and Higginson, who were con-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

stantly in search of another Calumet. For at various times he persuaded them to undertake a series of disastrous mining ventures in Mexico, only two of which ever showed any real promise, Yedras and Prietas. One, King entangled hopelessly in a complicated financial arrangement with an English company; the other, afterward a most successful mine, was sold on the representation of a rascally mining captain.

Had Agassiz and his brothers-in-law ever undertaken the management of these mines personally, or had Agassiz ever travelled in the field with King, whose optimism was greater than his judgment, probably the latter could not, after each successive failure, have hypnotized these gentlemen into embarking with fresh enthusiasm on some new venture.

Nor were these unsuccessful mining schemes limited to Mexico; their corpses lie scattered over the United States, — gold, silver, and placer claims in Colorado and California, bought under the best expert advice, coal lands in the South, and oil fields in Pennsylvania.

In the projects which he rejected, Agassiz was no more fortunate. One of the first to turn his attention to the Gogebic Iron Range, he decided against it, following the advice of a distinguished consulting engineer of the day, who reported to him that the region, now famous for its iron, was not worth developing. In the early days of the Rand he also sent an engineer to South Africa to examine a property, which afterward became fabulously valuable. Later, when he visited the district himself, he realized that had he been on the spot he never would have allowed the opportunity to escape.

Agassiz planned his journey to Yucatan with a view of seeing some of its ruins, for his travels in South

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

America had excited his interest in the old civilizations of this hemisphere. In the following letter, when speaking of this project, he expresses his intention of doing absolutely nothing till his return; it is curious to note in his letters from Yucatan to Mrs. Agassiz what his idea of doing nothing was.

TO SIR WYVILLE THOMSON

CAMBRIDGE, Nov. 26, 1881.

I am off in a few days for Mexico via Yucatan. The doctor says I must not be seasick any more for the next year, so I shall go on land and look up antiquities. I shall bring up in Mexico middle of January and ride across country from there to Gulf of California, to be about six weeks on horseback. I have an excellent companion in Clarence King, and we have also a first-rate cook as part of our escort. I shall do absolutely nothing except keep my eyes open and hope to come back a new man. While I am gone, my Report on Blake Echini will make excellent progress. I leave artist plenty of Plates arranged and I hope on my return to find the bulk of the Plates for that memoir done. There are now fourteen finished and ten more to make. This will make quite a dose even after the Challenger Echini. In meanwhile, to fill up time I am finishing a short paper on Young Fishes, which has been under way in some shape for more than eight years.

You will receive shortly, as soon as I can get them bound, a copy of the Challenger Echini via bookseller. It may seem a waste of material to duplicate yours and Murray's, but I don't want you to have a copy from anybody but myself, and hope you will put it on your shelves, and when you look at it sometimes think how

Digitized by Google Original from UNIVERSITY OF MICHIGAN

pleasant a task it has been to me and how much I have to be indebted to you for letting me have the Echini, and I trust you have not been disappointed in the result. It is of course not all it could be in histology and anatomy, but all that is necessary to a zoölogical and geographical point of view till we have a better idea in these respects of our ordinary Echini. I cannot say I am sorry my task is done; sometimes I felt somewhat overwhelmed with the work in addition to my other jobs, but now that I look back upon it, it is certainly most satisfactory, not only in the work but the pleasant associations it carries with it.

TO MRS. LOUIS AGASSIZ

MERIDA, Jan. 2, 1882.

Arrived here at last, Saturday night, after a very pleasant passage from Havana. But as we got to Progresso, the port of this place, a regular Norther set in and we had to lie at anchor all Friday without communicating with the shore, with the pleasant prospect of the wind lasting for three or four days, and then of being carried on to Vera Cruz without landing at all. Fortunately Saturday morning the wind abated and the boats managed to get ashore after a fashion. The American Consul met me at Progresso, passed all my traps through the Custom House without any fuss, and my only mishap was the loss of a spring overcoat, which, with the many changes made from boat to shore, to Custom House, to hotel, to wagon, found another owner.

Although we had all morning to get through before the train started for Merida, the delays of Custom House, etc., were sufficient to keep us busy till that had gone and we had to go to Merida, twenty-seven miles

Digitized by Google Original from UNIVERSITY OF MICHIGAN

off, in a wagon — what they call here a "volacache," a leather apron stretched upon a frame and suspended on two huge wheels, like the Cuban volantes, only with short shafts. This machine is drawn by three mules which go off at full gallop and keep it up all the way through thick and thin, puddles and dry, thanks to the howling and whipping of the Indian driver, who sits up in front while the passengers are extended full length on a mattress laid upon the frame of the wagon. The whole is covered with canvas to keep you dry and cool, and you hold on the best way you can on the standards of the cover to keep from going up to the ceiling.

The road is perfectly straight from Progresso to Merida, as flat as my hand, the whole rise in twenty-seven miles being about five feet; it is just like the roads in Key West; in fact my ride to Merida showed me what I had long suspected, that the whole of Yucatan was built like the Florida Peninsula of coral limestone. For about three miles inland it is nothing but a succession of low flats with pools lined with mangroves and heads of flat coral limestone, just as you find them at the eastern end of the Island of Key West. All this comes in admirably well with my ideas of the old course of the Gulf Stream and of its action in building up not only Florida but Yucatan. It will fill up my Blake chapter admirably well, and had I not seen anything else than this my stoppage in Yucatan would have filled my object.

On arriving at Merida I was driven at once to most elegant quarters which C——, who was in the class below me, engaged for me: in fact I have at my disposal here a huge parlor just now unoccupied, one of the finest houses in Merida, where I sleep, and take my meals at the Consul's. I am just on the Plaza with the cathedral

Digitized by Google Original from UNIVERSITY OF MICHIGAN

opposite; and last night being Tuesday and New Year's Day, it was a very pretty sight to see all the Indians, men and women, in their neat white dresses with elegant embroidery, sitting around or walking about smoking, chatting, and indulging in the usual lively Mexican way. I never saw such a clean lot of people, all got up in spotless white, well washed, well dressed, and evidently well to do. It's by far the best specimen of Spanish country I have ever seen; it's true it's not Spanish, but Indian.

I am in luck. I met here Charnay, the Frenchman sent out by Lorillard, who starts to-morrow on an expedition to Chichen,[1] where some of the finest ruins are to be seen, and I am going with him to spend there a couple of days. Had I known that Charnay was here and that I should catch him, I would have let Mexico slide and devoted myself to Yucatan, under conditions which I fear are not likely to recur again for some time to come.

Everybody here is very polite to me and I could have anything I want, I think — or perhaps it's because I want nothing they are so polite. If you happen to see Charles Norton, tell him of my good luck, and also tell him the way for us to get Yucatan explored is to help the American Consul here, Louis H. Aymé, who is an enthusiast, and who will learn with Charnay on his expedition all the practical part of taking moulds, etc., etc.

I am getting thoroughly rested. I sleep from nine till seven every day, am out in the open air all day, and I expect to get back from my expedition in tip-top con-

[1] Charles Eliot Norton writes Agassiz: "I am especially glad that you have had so good an opportunity to see the ruins of Chichen. No other living American, so far as I know, whose report could be trusted, has visited them."

Digitized by Google Original from UNIVERSITY OF MICHIGAN

dition, except perhaps a little hungry. The temperature is delicious, about 70° all the time, just what I like; why can't I introduce this reform, among others, in the climate of Cambridge? You will hear nothing from me again till I come back from Chichen. We start at daybreak to-morrow.

Love to the boys and the family. Please keep my letters, as it's my easiest way of keeping a journal — not that I want them for their literary finish!

TO MRS. LOUIS AGASSIZ

IZAMAL, January 7, 1882.

I write this on the chance of getting into Merida to-morrow in time for the mail. I have got back as far as this from my first trip to the ruins, and it has been a most successful and interesting trip. By the way, Izamal is about fifty miles east of Merida, in case you want to see where I have landed. The ruins I have visited are at Chichen, about one hundred and twenty miles from Merida, in an easterly direction. We left Merida at five on Tuesday last in one, or rather three, of these wooden riding machines on two wheels, such as I made my entry into Progresso. Mr. Charnay had a whole lot of traps for a ten days' stay and was of course well loaded with all sorts of things.

The first day, as far as Izamal, we got along nicely, the road being quite fair, and the mules were kept on the full gallop all the time except a delay of about two hours for breakfast at a sort of a halfway house called Cacalchen, where we had eggs and beans and oranges and coffee and tortillas. We passed the night at Izamal, but instead of staying at the comparatively comfortable place where I am to pass the night [now], we had to

Digitized by Google Original from UNIVERSITY OF MICHIGAN

hang our hammocks in the barracks and a dirty place it was, even for a Spanish town. We managed to get through the night, after a dinner much like the breakfast, and started at seven only, having waited patiently two hours after chocolate time, until our muleteers chose to go on. The American Consul is with us and he is supposed to have this expedition in charge and to have made all the necessary arrangements with the commanding officers, but somehow thus far the orders which were to have been issued have not yet met us, and all the way through till we got to Chichen, we got only promises and very little had been done.

The second day from Izamal to Tritas was pretty tough riding; if you will imagine a wagon driven at full tilt from the fort at Key West over the rocky beach to the redoubt, you have a sample of the kind of driving we had. We got to Tuncas, twenty-nine miles, to breakfast, glad indeed to have a little rest; here we got into the Indian country and I was glad to see that as far as escort was concerned we were all right; the road had been well guarded for the next stage, and we arrived at Tritas late, to find that all the plunder which Mr. Charnay had sent on two weeks before, to be sent to the ruins, was still there, and the evening was spent in swearing and trying to find horses and men to get all this forward. At last, by dint of perseverance, the necessary men were promised at five in the morning, and we went to hammock pretty tired. Next morning it was ten! before we got the men and horses and we pushed on fast with the horses and a light escort and reached the ruins at two.

You cannot imagine the damage these Indians have done; they still hold the greater part of Yucatan, ex-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

cept a narrow strip along the seaboard, and have never been subdued; and no wonder; you might as well try to drown a cloud of mosquitoes as attempt to get at them through the woods where they retire. Every little while they make a dash into the small settlements and destroy everything. Tritas used to be a prosperous place of fifteen hundred inhabitants; there is nothing left but a few houses and half-breeds. On the way to the ruins we passed a couple more villages entirely overgrown with trees about ten years old, so that had they not been pointed out you would never have suspected their existence. We had seventy-five men escort and about fifty more men had been sent ahead to clear away the rubbish from the ruins, so that I had all that afternoon and the next day to see the remains found at Chichen.

Look in the Stevens which is on my shelves — Stevens's "Yucatan" — and you will find a good description of all I have seen, only the ruins are fast going to the dogs, and in the last twelve years, since Mr. Charnay was here, the changes have been very great, and with this rate of destruction nothing will be left of these magnificent ruins except piles of stones. At Izamal there are also pyramids which we examined on our way. The two nights I spent at Chichen we lived in the ruins in the "Castillo," so that we were perfectly safe from attack, and the men besides were all out on picket and careful watch kept — but all was quiet.

The only drawback to this expedition has been the ticks; you get perfectly covered with them; they are very small and sting in proportion; the after effects especially are very unpleasant.

I kept an eye on the geology of the country, which is most interesting and supplements the history of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Florida wonderfully well. I don't believe these ruins are very old. Pieces of timber used as lintels and bars are still well preserved, and in this climate that does not mean a great antiquity. It's the old story again of Peru, and the accompanying gushing history.[1] The Indians of the present day are a fine set of people and still adhere to their old language and do just what their ancestors did, at least if we can judge from the paintings on the walls which go into very minute details. Some of these drawings are wonderfully well preserved, and the stone carvings quite good, but everything is rude and shows but little art.

What a pity these ruins are not in a civilized country where they could be studied and preserved and perhaps restored. I hope to arrange to go to the other ruins to-morrow, and shall be gone again till the end of the week, and have then a few days to get rested after my return from Uxmal. That's in a perfectly safe country. But it is stupid going about alone, especially when the travelling of the day is over and you have nothing to do all the afternoon and evening. I shall not be sorry to be quiet for a few days again before going to sea, for this is rushing it and rushing it is pretty rough work — but to take it more leisurely would be impossible except to a professional loafer or a Spaniard.

TO MRS. LOUIS AGASSIZ

MERIDA, Jan. 17, 1882.

Returned yesterday from Uxmal and found quite a package of Cambridge letters. Rodolphe's letter was

[1] From what he had seen in Central and South America, he believed that the Incas and allied races were not as highly civilized as is generally supposed.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

very good and quite legible; make him write often. I wrote him a little note by the last steamer to tell him there were no monkeys here and that he would get lizards later in the season, so that they should not freeze on the way.

I am not sorry to have a couple of days to rest, for my trips to the ruins have been pretty fatiguing. I have made a little over four hundred miles over perfectly infernal roads; what with starting at daybreak, getting well shaken to pieces, with very poor food, and sleeping in hammocks, it is not conducive to comfort. I am beginning to feel that I cannot get along without more nourishing food than I get in the tropics, and I must manage to keep hereafter within more civilized regions, where the food is not simply beans and tortillas and coffee and chocolate and a very occasional egg, with nothing to drink but beer; fortunately I was warned of this state of things and took with me some claret so that I managed pretty well. But I feel pretty tired and I don't think it's good for me to live in this way — I lose ground. I have also had signs of my old trouble again, which probably accounts for my being so tired; if there is any trace of it left when I get to Mexico I shall have to give up my trip in the interior and come home by way of Vera Cruz. What seems to use me up is the shaking of the coaches. I thought I was perfectly strong again, but it seems I must still be careful.

This last trip to Uxmal has been a most interesting one. Mr. C——, who was in the class of '56, and who has been most kind and attentive to me, came to Uxmal with me, so that it was very pleasant and not in the least lonely. At one of the haciendas where we passed the night we were joined by his cousin and two more

Digitized by Google Original from UNIVERSITY OF MICHIGAN

friends, who kept us company to the ruins, and from there we went back to the hacienda of Mr. —— to spend the night before returning to Merida. This gave me an excellent chance to see something of the way of living of the better class — in fact of the swells of the State.

I must frankly say that it is appalling what barbarians they still are, at least a hundred years behind the age. How anybody who, like C——, has spent four years in the United States and subsequently studied eight years more in France, can have gone back to this semi-barbaric state passes my comprehension. They eat like pigs, sleep ditto, and have a holy horror of fresh air and cold water. The latter they think is sure to give you a fever, and they keep a scarf over their mouth for fear of allowing the least miasma from entering their lungs. Not one of the decent comforts of life to be found in any of the swell haciendas where we happened to stop, either for breakfast or for the night, and although the overseers had all been warned we were coming and to be ready for us, there was very little to eat, and they did not seem to know how to make use even of what they had. They gave us some wretched beef and potatoes, while there were pigs (young) and oranges and plantain and all kinds of vegetables, growing all round; and then the dirt and the fleas and the ticks we got while running round the ruins — all was not conducive to make me look on the bright side of things.

Still in spite of all this the trip has amply repaid me and I have enjoyed it immensely and learned a great deal. When I have seen the pueblos near Santa Fé, I shall have a pretty good idea of American archæology. I will not go into details of the ruins of Uxmal,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

but refer you again to Stevens, whose account is most accurate.

Everybody here is very polite to me, in fact too polite, as the exertion of speaking Spanish and keeping it up any length of time is nearly as tiresome as riding the same time over a very rough road, and when it comes to talking philosophy and religion, as some of the people here are very fond of doing, and theorizing all round, it's too much for me.

Going to Vera Cruz by steamer, he continued by easy stages to the City of Mexico. From there he writes: —

"I wish I had Charles Norton, or some other classical enthusiast here. I think I could show him exactly how the Roman barbarians, who lived in Pompeii and Herculaneum, lived, and they would form a very different idea indeed of that so-called ancient civilization. All the little shops, especially the drinking saloons, are frescoed, some of them with considerable attempt at art; and I dare say the shops and bar-rooms of the ancient Romans, of which we admire the mural paintings so vastly, were nothing but the daubs of the sign painters of the day. I wish I had the time and skill to write a picture of the scenes of this Spanish life as you see it here, and compare it to the Roman period; something very good might be made of it. Imagine our friend, Wyeth, in Harvard Square, selling his wares behind a counter with walls ornamented with the sacred history or with views of the Indians and their fights with the Pilgrims, or scenery of the Rocky Mountains; or Pike[1] receiving his orders

[1] A keeper of a stable formerly frequented by Harvard's *jeunesse dorée*.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

for carriages in an office, the rear of which is a shrine for the Virgin Mary, with a magnificent wax doll and burning candles, before which some of the faithful are going through their ordeal."

Writing to Mrs. Agassiz a few days later he says: —

"I am gaining little by little and am able to do a good deal more than when I came to Mexico; still I get very easily tired, and a stage journey finishing with a horseback journey is out of the question. It 's intensely stupid here in the hotel; were I on the seashore I could do something, but here in the midst of a great city I am at a loss for occupation. I only dare to make very short excursions in horse-cars to surrounding country."

He returned to Cambridge late in February, for the state of his health prevented not only his trip with King, but also any further travelling.

TO SIR JOHN MURRAY

CAMBRIDGE, March 10, 1882.

I was thunderstruck this morning to see the notice of Thomson's death in the papers. I had no idea he was so near his end from anything you said or I had heard, though from your last letter I greatly feared he never would be able to finish his Challenger narrative. It is a great loss to science, and it will be next to impossible for anybody to write that narrative. His experience and all he had thought and written on the subject cannot be found combined in any one man, and it will be long before we have one who knows so much and says what he knows in such a charming way. I shall feel his loss

Digitized by Google Original from UNIVERSITY OF MICHIGAN

greatly; the death of my own brother could hardly be more heartily felt, and I shall sadly miss his correspondence. He was one of the few scientific men from whom I liked to have frequent letters, and to talk over plans of future and discuss the past. I was greatly in hopes that when he was freed from all anxiety regarding his professional duties he might be able to work again moderately and accomplish some good work yet.

In the early winter of 1882–83 Agassiz passed a few weeks in Florida, where he went with one of his sons, who had not been well and was ordered to a warmer climate. But the rest of the winter he was forced to pass in Cambridge in charge of many business matters, that fell to him owing to Mr. Shaw's illness and absence in Europe.

TO ERNST EHLERS

CAMBRIDGE, Feb. 3, 1883.

It is quite a while since I have had the pleasure to hear from you. I trust all is going on well with you and that it is only as with all of us, press of work which has kept you from giving signs of life. I hope you receive regularly our publications, both the Museum and mine. You will have noticed that the Blake Reports are getting on quite well, and I am in hopes now to have the remaining ones shortly, so that I can finally go to work at my popular account, for which I am accumulating material so fast that I fear I shall be overwhelmed by it and lose my way in selecting what is needed. How are you progressing with the Annelids? I have been since I wrote you last, as usual, a good deal of a wanderer, and each year I find it harder to stand our hard

Digitized by Google Original from UNIVERSITY OF MICHIGAN

winters. This winter I am obliged to remain at home owing to the serious illness of my brother-in-law, which has thrown all his business on my hands. I am making excellent progress here with the Museum, and next fall I hope we shall be installed in our new laboratories, and that hereafter I may be able to devote some of my time and energy to the laboratory part of the establishment, which has suffered considerably from want of proper accommodations; but now we shall soon catch up and with the assistance of my colleagues here I hope we may build up a satisfactory and effective biological school here.

I am always dreaming of going off dredging and sounding in the Pacific; my mouth waters at all the problems there are to be solved, but whether I shall ever get off is another question. It is practically impossible to get the Government to do anything, and we must depend on private means to fit up a large steamer, for the work I wish to do requires a good deal of money. Still I hope I may accomplish it before I get too old to enjoy it.

TO HUXLEY

CAMBRIDGE, MASS., April 23, 1883.

MY DEAR HUXLEY: —

It becomes my pleasant duty to inform you that at the last meeting of the National Academy of Sciences held at Washington you were elected a Foreign Associate. The proper diploma will be forwarded to you in due time, and I hope you will not object to your Associates who move in the first colored scientific circles on the other side. This notice is not perhaps as formal as it should be, but I trust the stiffness of the parchment

Digitized by Google Original from UNIVERSITY OF MICHIGAN

will make up for the informality of this "first of Exchange."

Always yours very truly,

A. Agassiz,

Foreign Secretary, N. A. S.

TO HUXLEY

Newport, Sept. 10, 1883.

I am getting now to work seriously at my final Blake Report for the public, and should like greatly for the Cephalopods to include an account of the "Spirula," of which I sent you the only specimen we had for comparison with those of the Challenger. If you are sufficiently well advanced not to need the specimen any longer, I should be glad to have it again. If not, and you could send me proofs of your Plates on the Challenger specimens and a short account of the peculiarities of our specimen for use here, and copy of what you think might be interesting in a popular account of the Natural History of such an expedition as the Blake, I should greatly value it. Of course any such copying of your manuscript as is required, please have done at my expense. I have nearly all the Preliminary Reports of the different departments in, and trust the Report will not be delayed so long that nobody will care to hear about the Blake any longer.

I hope you have received by this time a short Memoir of mine on the Florida Reefs, and the first part of one on Porpita and Velella, and being old friends of yours may interest you.

I had the pleasure of having Sir Charles Bowen to dine here (Newport), and am greatly obliged to you for giving me a chance to make his acquaintance.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

I have this summer gone back to my Fishes and with the help of an excellent assistant, C. O. Whitman, have some good things. We shall hope to publish early next year a good Memoir, made up of all my accumulations for twenty years and a careful revision by an outsider during two years.

I almost forgot to say how pleased your friends here were at the action of the Royal Society in electing their new President!

In the winter of 1883–84 Agassiz chose India as the goal of his annual journey to get away from the cold weather. His letters from there are those of a casual traveller in a well-known land, who obtained his first glimpse of the Himalayas from Darjeeling, and visited most of the cities which make India a pilgrimage to the English. One of his experiences was, however, unusual, for he saw the installation of the Nizam at Hyderabad: —

"To this I had been invited, thanks to the kind offices of Colonel Chapman, the military Secretary of the Commander-in-Chief (General Stewart), whose acquaintance I made on the way from Brindisi to Bombay, who not only made out my itinerary but also gave me letters to all his friends and acquaintances, and I was thus passed on from one delightful bungalow to another until I returned to Bombay. At Hyderabad I spent three days during the festivities of the installation, living in part in camp with other invited guests, having a huge tent, an attendant of my own, a bed-room and sitting-room and tent for a bath-room, and all the guests dining together in a huge tent and meeting after dinner

Digitized by Google Original from UNIVERSITY OF MICHIGAN

in another of still greater size. The last day when the ceremonies were over we were allotted to sundry "big bugs" of the city to see the illuminations, the like of which I have never seen again, the whole place illuminated by hundreds of thousands of colored oil lamps of all shapes and sizes.

"I was most fortunate to be able to see this first Durbar; the natives in all their glory, bedecked with pearls and diamonds and rubies and other stones, in great contrast to the dark European clothing of the guests, the dresses of the ladies and the gay uniforms of some crack English regiment alone relieving the monotony of the European side of the festival. I shall never forget the sullen look of the chiefs, as they seemed to feel the Nizam or some of the natives had been slighted, and certainly the mode of procedure of Lord Ripon was enough to irritate the dullest susceptibility. Everything seemed to be done to aggravate the native princes, and it was not a pleasant feeling to know that there were 300,000 native troops in a city of the same number of people, all fanatic Mohammedans ready to break out at the least provocation, and to oppose them was one regiment of Lancers and a horse battery of artillery.

"I was quartered with the Nizam's brother-in-law, who had been educated in Europe and spoke French, and I, being an American, he and the Afghan chief with him did not hesitate to express their feelings towards the English. The Nizam's brother-in-law lived in a palace built in a square with a huge wooden door protected by small field guns and a small garrison ready to defend it from outside attack, half a dozen huge elephants ready to start up and charge any mob that might make themselves unpleasant.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

"With one of the Afghan chiefs we went to take an elephant ride through the narrow streets of Hyderabad, with a howling escort preceding us and an equally disreputable crowd yelling and hooting behind us, swinging their guns and spears in a most careless manner. I don't know which seemed the most dangerous, the escort or the populace which followed us. The crowd was so great that the elephants could only proceed at a very slow walk, putting out their trunks and one foot at a time to push aside the solid mass of people which confronted us and which seemed to rise on the sides of the walls of the houses as we slowly forged on."

Early in the spring Agassiz was back in Cambridge, bringing with him a very complete collection of photographs of Indian architecture, and some superb pieces of old jewelry.

TO SIR JOHN MURRAY

NEWPORT, Aug. 3, 1884.

I have to thank you for Vol. I of the Physical Chemistry of the Challenger, which came safely to hand, and which I've just dipped into a little. How are you getting on with that Preliminary Report on the bottoms? Are you coming over this year to the scientific meetings? If so, don't fail to drop in upon me here. I shall not budge. I've been so keeled up since July — good for nothing, and the doctor says the warning I have this time is one I can't afford to neglect and that I must give up everything I possibly can. So I shall stay here principally and hope that a few of my friends will drop in on me, but I am getting poor company just now. I hope to finish my Blake Report, but that of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

course is postponed for the present and I shall do well if I can keep away from the undertaker. Everything was arranged for me to make a dredging trip — Guayaquil, Galapagos, Panama — next spring, and owing to some cussedness of the Treasury Department the whole thing is knocked in the head, and I had a fine chance to use a 700 ton steamer which will pass over the district and do nothing!

Financial affairs here seem to be going to the eternal bow-wows, but I hope the fall will stop before we reach hell, but just now the more you have of anything the poorer a fellow feels.

How are you getting on for funds for the new Biological Laboratory? I see you have plenty of names, but how's the cash? Lyman has returned from Washington for the present till fall, but he is so anxious to be returned again (election in November) and so deep in politics, that I do not believe a new deep-sea Ophiuran even would turn him aside from his politics.

TO F. A. FOREL

CAMBRIDGE, Oct. 10, 1884.

I have just got your letter of Sept. 17th announcing that the Société Helvétique des Sciences Naturelles had done me the honor to elect me an honorary member.

Please be kind enough to thank the Société Helvétique for having inscribed my name among its members. Permit me also to thank you for the extremely kind way in which you send me this news. Although I left Europe when very young, and have become a complete American, it is with great pleasure that I receive the tokens of approbation that my Old World colleagues have done me the honor to show me.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Some years later, in acknowledging his election as a Foreign Member of the Royal Society, he wrote, "Although I have little ambition, yet I have a very soft spot for the praise of my peers." Certainly no man ever cared less for empty honors, but he valued the recognition of scientific men.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

CHAPTER X

1885–1890

MORE WANDERINGS AND WORK

Agassiz's usual winter pilgrimage led him in 1885 to the Sandwich Islands, whose hospitable shores were in those days ruled by that genial and unconventional monarch, Kalakaua, who was only too ready on the slightest provocation to throw off the burdens of royalty. Agassiz spent the greater part of the winter roaming among the islands, sometimes a guest on some great sugar plantation, sometimes exploring the wonderfully picturesque gorges in which the islands abound, visiting the volcanoes, or studying the coral reefs, often in some native outrigged canoe, which his Hawaiian fishermen skilfully steered along the edge of the breakers pounding on the reef flat.

Honolulu, Jan. 27, 1885.

"I arrived here on time after a good passage as compared to an Atlantic one, but in spite of this I was more seasick than I remember having been for a long time. I have spent the time thus far in making up for my lost meals and riding and rowing round the island. The scenery is very pretty, and there are endless trips to be made and a great deal to see. Thus far I have done nothing except have a good time, and when I get back from my trip to the other islands I expect to spend my time in looking up the coral reefs and something of the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

marine world of the place. This is a most charming contrast to Florida where time hangs so heavy on your hands. Here there is something new to see and to do the whole time. I had the good luck to make the passage with the great California sugar king, Mr. S——, a smart, self-made German, who really controls everything here; he has given me letters to his agents on the two islands I visit, and I shall be well taken care of. I find that all my letters from General Armstrong are to the missionary crowd, so that I shall wait to deliver them till my return. That crowd hates S—— and I can't throw him overboard now — at any rate I don't propose to, he is too sensible a cuss and very entertaining. I have had an audience with his Majesty Kalakaua! He appears a most inoffensive and good-natured animal. But it is a pity to see the natives — they are withering before the whites, and soon the islands will of their own weight fall into the hands of the Americans."

After three days spent in examining the volcano of Kilauea, he writes from the little village of Hilo on the Island of Hawaii: "I was greatly disappointed at the coral reef here, which amounts to nothing; and at the amount of sea life; there is more in a square inch at Nahant than on the whole beach of the Bay. I am very well and enjoying every minute of my time. Hope all is going on well at Museum."

An amusing little incident, during his wanderings about the islands, shows how unexpectedly a bit of abstract science may be of the greatest practical value. One day as Agassiz was sitting with his host on the porch of the house of a great sugar planter, he noticed a schooner discharging a cargo of lime in the roadstead.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

"Why," he asked, "are you importing all that lime?"

"Because," replied his host, with evident contempt at his ignorance—"because we use it in great quantities on the plantation."

"Yes, I know," said Agassiz; "but why don't you make it?"

"Make it! How can I?" exclaimed the planter.

"All this rock about here is pure limestone; you have only to burn it," Agassiz answered.

"My God!" said his host, "and I've been importing it for years."

WAILUKU, MAUI, Feb. 14, 1885.

"When you get this you will know I am back again in Honolulu, where I shall spend the rest of my available time studying the coral reefs. I have enjoyed this past week very much, riding round the different plantations, seeing the mountains. Some of the scenery here is indeed beautiful and many of the gulches must be far more beautiful than anything in the Yosemite Valley. I made the ascent of Haleakala—the extinct volcano of this island—very successfully, and after having seen the active one on Hawaii you can realize what this one must have been when active. The crater is about thirty miles in circumference, filled with lesser cones and vents on an immense plateau—which is desolation itself, sunk about two thousand feet below the edge. The view from the top is one I shall long remember, so totally different from anything else I have ever seen. You are ten thousand feet above the line of the sea and can see the horizon towering all round, so that you feel as if you were in the bottom of a saucer, trying to look over the rim.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

This trip has, I think, done me more good than any other I've taken. I have practically been out in the open air ten hours a day during the past fortnight, riding nearly the whole time from twenty to thirty miles a day. The horses here have just the gait that suits me, and I feel as strong and tough as an ox just now. I wish I could stay as I am now. I must manage when I get home to get more exercise and shaking up."

TO H. N. MOSELEY [1]

CAMBRIDGE, April 9, 1885.

Here I am back again from the Islands of the Blessed after a most delightful trip. I came across your tracks at the Volcano House, and those of the Challenger party. I spent three days up there and was loth to leave. I worked very little, devoting myself to hard riding and walking and seeing all I could. I managed, however, in making the round of Oahu to look up the elevated coral reefs and to study the reefs of Honolulu and of the weather side of the island, also the æolian limestones of Maui, which are most interesting and throw very considerable light on the elevated reefs of the extremity of Oahu near Kahuka Point. I have not yet had a chance to see what Dana had to say about them.

On my way back I again came across your chirography at the Hotel of the Grand Cañon of the Colorado. I hope you stopped at Flagstaff to see the cliff and cave dwellings near the station. I had an interesting time there and at Laguna where I went to see the Acoma Pueblo. I also put in a few days of antiquarian work at Santa Fé, went to the San Juan! and [undecipherable] Pueblos, but they did not compare with the Acoma

[1] Of the Challenger staff.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Pueblo; the pueblos near Santa Fé have felt the influence of civilization too plainly; they are too near an old European settlement. I have now seen all that is worth seeing in the way of the ancient North and South American ruins and shall try my hand sometime at presenting what seems to me the true explanation of the unity of race of all the people who have taken part in their buildings and whose path can, I think, be plainly traced from the North where they are hunters, to the agriculturists of the Pueblos and of Yucatan and Mexico, to similar buildings in South America (Peru and Chile), till you come at last to the hunters again of Patagonia and the Eastern steppes of the Andes.

I am very sorry to hear of Mr. Jeffreys's death and was very greatly surprised to find that his favorite collections were to go to Washington. It will be most valuable to us. But how and why did the B. M. permit so valuable a collection to leave England?

TO ERNST EHLERS

CAMBRIDGE, May 22, 1885.

Many thanks for your offer to send me hereafter the numbers of the "Zeitschrift" as they appear. The simplest way is, as you suggest, to send it directly by post. I shall be very glad to get the manuscript and plates of your final Report.[1] There are now not many more to come in, and I shall not be sorry to have that off my hands and devote myself again to my seashore work and to the publications of the work done by Museum assistants. We have now, I am happy to say, got along so far with the Museum that I do not propose to spend either so much time or money in collections. The Pale-

[1] On the Blake Annelids.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

ontological Rooms alone now remain to be done, with exception of the marine faunæ, and I can take my time about all this and start the work more in the direction in which I should have been most interested — that of publication of work of students and of professors engaged here. I feel as if I had done my duty to the Institution I have inherited, and at my age — for I fear we are all getting on — I have not a great many working years to start the Institution in the direction in which I should like to see it develop. Had I the Museum alone to attend to, I would move fast enough and make progress rapid enough even for my taste; but what with all the claims of the University in various directions, and the necessity of hunting up funds to carry out projects, it seems to leave but little time for scientific work proper, and I often feel as though when I got ready to work my time would be past. That is the great misfortune of having to work in a new country where everything is to be built up and nothing is accomplished without spending the lifetime of private individuals in doing what a Government does for you in a few years.

TO SIR W. H. FLOWER[1]

NEWPORT, Aug. 12, 1885.

Many thanks for your kind note of the 21st July, and for the pleasing information regarding the Hume collection. I shall look forward with patience to its coming and am very glad to entrust our interests to your care and Mrs. Flower's. I am thankful the collection is at last safely housed.

I have been hard at work this summer preparing the text of my final Blake Report, and trust to finish it this

[1] Director of the Natural History Department of the British Museum.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

fall and leave it to await the finishing of the illustrations during next winter. I hope I may get across and on my way to warmer climes find you in your new quarters. Please give my kindest remembrances to Mrs. Flower and my congratulations and best wishes on the marriage of your daughters. My boys are getting on; the eldest is now 23, and having passed through Cambridge, has caught the cowboy mania and is herding cattle in Arizona. The second is devoting himself to growing, and having reached 6 feet and 190 pounds I hope he will stop. The baby is 14 and is the only one I depend on much, and this will not be for long, as he is looking forward to college. I was sorry to hear from young Carpenter that Huxley was no better and was giving up all his posts. As for myself, I have turned over a new leaf, giving up all work for other people, becoming thoroughly selfish, and the result is that I feel like a fighting cock and hope now to be able to do a few things in which I am interested before I lose all my go. I hope this fall to get out the first part of an extensive paper on Embryology of Fishes, which you will receive in due time.

In the fall of 1885, President Cleveland offered Agassiz the position of Superintendent of the Coast Survey and scientific adviser of the administration. Agassiz was much touched and pleased at this mark of appreciation, coming as it did at a time when the Coast Survey was not the only scientific government bureau that showed evidence of a need of reorganization, a condition of affairs that had greatly troubled him, and in which he had attempted to exert his influence, only to call down the animosity of some of the scientific men at Washington.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

However, he felt that it was out of the question to consider the offer, for he thought the post should be filled by a professional mathematician or physicist; the necessity of leaving every winter for his health was also an objection, to say nothing of the interests which held him at Cambridge, and the sacrifice of his own scientific work that such a position would involve.

TO E. L. GODKIN[1]

NEWPORT, Sept. 30, 1885.

Your dispatch came duly to hand and I hope the reply reached you. I am sorely tempted to give up everything and go to Washington, for to become the chief scientific adviser of the Government and be able to influence legislation as far as can be done, on behalf of science, is a thing of which any man might well be proud, and not lightly to be declined. Were I five years older I would not hesitate a moment. But I am afraid of taking hold of a new thing on account of my health. I am just getting out of the woods and my private interests, on which my scientific future depends, are in such a condition that I could not in justice to others leave their management at present in untried hands, so I had to decline.

Still there is the other side. I fear I should be much like a bull in a china shop; what with red tape, and etiquette, the Superintendent to be, who is somewhat of an autocrat, might have a hard time. It has been most gratifying to see how unanimously my scientific colleagues and friends, as well as the public, have approved the choice of the President, and the manner in which it was offered to me by him through the Secretary of

[1] Editor of the *Nation*.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

the Treasury, was cordial in the extreme and most flattering, for I had been sounded in the middle of the summer and had given a most emphatic denial at that time.

The following winter (1885–86) he went to Egypt, which had not then become the great playground of Europe and America, dotted with the huge caravansaries which meet the modern tourist at every turn. Those were the days of the insurrection on the Upper Nile; the Soudan was in possession of the followers of the Mahdi, and all travel above the First Cataract was suspended. "There are not many travellers," he writes, "but there are also very few facilities for getting anywhere, the Government having seized everything that can float or walk to transport troops and materials to the Soudan."

The place that he had engaged on a boat up the Nile was requisitioned by an English officer, and he was obliged to wait for a later steamer. He had the good luck to reach Assouan, the end of his journey, just as the Cairo Museum was opening some tombs in the neighborhood. On his return to Cairo, finding that all the steamers for Italy were full, he took passage for Constantinople, stopped a couple of days in Athens, and returned to America by way of Vienna, Paris, and London.

TO HIS SECRETARY, MISS E. H. CLARK

ATHENS, March 1, 1886.

Athens is a very clean and wholly uneastern place, the native costumes of the men and women very gorgeous, that of the women specially so, but few of them however wear it in public. It being carnival time there

Digitized by Google Original from UNIVERSITY OF MICHIGAN

were rather more than usual out. Everybody here is on tiptoe about the war. You see nothing but soldiers in the streets, and it's melancholy to see a small country like Greece spending all its substance in army and navy. The ruins here and collections are most interesting, but strange to say they are not half as well cared for as are the Egyptian ruins, and considering all the talk that classical people all over the world make about Athens and all her glory, the state of the ancient remains and collections is a disgrace to the cultivated races. However, it has always been that way. Whenever the classical people and the literary cusses want anything, they always appeal to Government. They never think of the simpler method of putting their hands in their own pockets.

I have got hold of a very pleasant Englishman who is going to Vienna and who has been with me on the steamer from Alexandria, and we shall keep company till Vienna, where he stays for a time. So it will be quite pleasant to have a decent travelling companion and some one to talk to.

CONSTANTINOPLE, March 9, 1886.

"I have been much disappointed at this place. It has lost nearly all its Oriental charm, having been greatly spoiled by European influence of the East. It has kept only its dirt. The bazaars are very poor and there is little to be bought here except a few Persian things and rugs, of which very fine ones could be picked up with ample time to waste in bargaining and sitting still. It takes about four days to buy the smallest thing at a reasonable rate.

We had a miserable passage from Athens here, and

Digitized by Google Original from UNIVERSITY OF MICHIGAN

it was a delight to all to get into the smooth water of the Dardanelles. Such a wretched little steamer; the Blake was a floating palace compared to her. We were also blessed with the most abominable set of passengers, a couple of German swells and a French count, who were at the same hotel at Athens, where they had managed to make themselves as offensive as possible to everybody. They continued the process on the ship and came near being thrown overboard by some Italians who thought themselves a good deal better than they were. Everybody was sorry they were not drowned."

TO HUXLEY

CAMBRIDGE, MASS., April 17, 1886.

Your capital letter on the subject of the English Fishery Board has been republished on this side, much to the disgust of the friends of general and unlimited government coddling of science. Our weak-kneed periodical "Science," which is strictly impartial and therefore represents nothing, has during the past winter been crowded with articles on the beauty and benefits to be derived from federal pap liberally supplied to every crank who has a scheme. The unfortunate dissenters, who, like myself, don't believe in such a policy, have been held up to the public ridicule as simple-minded and nearly idiotic cusses who had no conceptions of the grandeur of science! It makes very amusing reading, but it 's somewhat discouraging to see criticisms of opinions uttered frankly dealt out in such a spirit, and will make me at least most careful how I give my views to Government committees, if the men of science in the country are bent to warp and misrepresent the plainest statements and involve one in endless and useless dis-

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

cussions. I've come to the conclusion that my best plan is to mind my own business, and devote my time to work and the publication of what I have to say, and leave these discussions to be carried on by the other side alone.

CALUMET, Oct. 4, 1886.

"I never saw anything like the steel pens here — they are simply abominable. I shall have to bring up my own quills hereafter, or I run risk of spoiling forever my otherwise striking chirography. The weather to-day is superb again. I have taken advantage of the day to take a general survey of the location and of the proposed alterations and additions, and by to-morrow shall have seen all the surface places, and then will make out a program for the next five years, which will open the eyes of all concerned; and in five years from now there is nothing I have dreamt of I cannot then carry out, even if copper goes to ten cents !! again, which I don't think it will for a while at least.

I shall be hard at work for a while here and hope by middle of the week to be able to say when I can leave. But I shall have to come back by way of Philadelphia and see the builders who are to make all the new equipment and make sure we can carry out the program, for it is one which will tax the largest shops of the country to the utmost, and to make time as laid out on the time-table of the proposed duplication will need all the management and forethought possible. But if I succeed it will be the greatest thing ever done in a mining way. I have not yet had a chance to go to the mills where the great changes have taken place and see what has been accomplished. The fact is, I've only just awakened to the discovery that if I had spent my thoughts and capi-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

tal on Calumet the last ten years, instead of all the other moonshine enterprises in Mexico, etc., I should now be a very rich man, and be able to do all I have ever dreamed of in my wildest days. However, it is not too late, and if I can carry out my plans, which seem perfectly feasible to the men here, I shall in less than five years treble our dividends.

I am up early, run round all day and talk all evening to the various bosses and hear what they have to say and suggest, and think that by the time I get off the whole plan for five years will be laid out like a timetable, to which we can work and lose no time if we take matters in hand now.

The weather continues magnificent. Went to Lake Superior yesterday. The woods are superb now, and I enjoyed tramping along the shores and trying to find a suitable site for the location of waterworks which we shall shortly have to put up to supply this place with water, as all the wells are being dried up by the mine as it gets deeper and deeper."

But such rosy prospects were unexpectedly postponed by a series of disastrous fires in the timbering of the mine, which, had it not been for Agassiz's ingenuity in devising new methods for extinguishing them, would probably have resulted in an overwhelming calamity. The burning portions of the mine were sealed, and steam forced into them through pipes that led well down the shafts; later carbonic acid gas was manufactured on a huge scale, and many million feet were forced into the mine in the same way. Such devices proved successful in eventually extinguishing the fires, but the mine was crippled for a number of years.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Writing to Murray in January, 1888, Agassiz says: "We ought to have made millions by the rise in copper; it unfortunately caught us with a fire in the mine, which is still burning, and I have had the satisfaction of seeing others reap the benefit of a state of things for which I had been hoping for five years. It is aggravating to have things happen as one anticipates, and then when the time comes, to be knocked out of time by such a disaster as has hit us. However, better luck next time."

By October he writes from Calumet: "Everything is humming here, and if we keep on as now, no accidents, we shall nearly catch up all our copper allowance[1] by January 1, and after that are sure of $30 to $35 per share as long as the syndicate lasts — two years at $35, and then from $40 to $50![2] after the equipment is in. It begins to look as if I might yet have my [exploring] steamer."

Still another fire further crippled the mine; early in 1889 he writes: "Calumet is at last put out again, but I fear the damage of these successive fires has been very great and will use up much of the profit." A few months later he says: "I find things at the mine in much better condition than I feared the fire would leave them after being closed so long. So I shall go back greatly relieved and trust this will be the end of our burning. It's getting to be worse than the fire of the Vestal Virgins."

But to turn back again to his more congenial fields;

[1] Refers to an arrangement with a French syndicate that attempted to control the copper market of the world.

[2] At its most prosperous period, Calumet paid $100 a share in one fiscal year.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

for, apart from his interest in the development of a great industry and the welfare of its employees, he always regarded Calumet as the means that enabled him to accomplish his scientific work. In the fall of 1887 he characteristically writes Murray: " I am getting on well with my Blake Report and hope to have the d—— thing out soon. I've done nothing this summer but correct proof and am almost dead." That winter he found time to visit his confrères in Germany, Paris, and London, going down to Cambridge before returning to its namesake in the New World, to receive an honorary degree. Marks of recognition of his thalassographic researches were now fast accumulating from all parts of Europe; in the summer he was elected a Corresponding Member of the French Academy of Science.

The first few lines of the next letter refer to the so-called "Conspiracy of Silence." On the return of the Challenger, Murray had been advised not to publish hastily his theory of coral reefs. This had delayed its appearance for a couple of years. The Duke of Argyll, stumbling across the fact, had construed it into a deliberate attempt on the part of the English scientific world to suppress the truth, for fear of injuring the prestige of Darwin, who held different views in the matter. This called forth an indignant protest from Huxley: he afterward, however, wrote Agassiz: "I beg you to believe that I had not the slightest intention of posing as a defender of Darwin's views [on coral reefs]. My purpose was to deal with the Duke's charges against the honor of scientific men, and I did not want to diminish the force of my blows by raising any side issues."

Digitized by Google Original from UNIVERSITY OF MICHIGAN

TO SIR JOHN MURRAY

CAMBRIDGE, DEC. 2, 1887.

I have been greatly amused at the articles in "Fortnightly" and "Nature" by the Duke, Huxley, and Bonney. I am surprised that Huxley should have taken up the cudgels in favor of Darwin's theory. But Huxley has always hankered after a sunken continent in the Pacific; and Darwin, who has always objected to that kind of juggling with continents, could not resist when it came to coral reefs to do just the same thing, and calls the reefs of the Pacific, if I remember rightly, the last traces of a sinking continent! It is no use to talk of subsidence in the Yucatan plateau in case of such a fine atoll as the Alacran, or on the Florida Reef in case of Marquesas. Still we can wait and let them fight it out. I was somewhat surprised in Darwin's Life to see the element of wishing his cause to succeed as a cause brought out so prominently. The one thing always claimed by Darwin's friends had been his absolute impartiality to his own case. Certainly his correspondence with Hooker, Huxley, and Gray shows no such thing. However, I don't want to branch off. The book is a mighty interesting one and admirably put together.

TO FRITZ MÜLLER

CAMBRIDGE, May 28, 1888.

I hope that by this time the Life of my father has reached you, and if it has not please to let me know and I will send you another copy. But if you can indicate to me any safe method of forwarding, I should of course like to avail myself of it. I trust that my "Three Cruises of the Blake" has also arrived safely and that you will

Digitized by Google Original from UNIVERSITY OF MICHIGAN

find some interest in this sketch of the western Atlantic off our shores. I have been nearly five years working this up, and am not sorry to have this work behind me and to be able to go back again to my Laboratory at the seashore and my embryological work which I have so long neglected. It was to me a bitter disappointment not to be able to join the Albatross at Panama, but owing to the severe and dangerous illness of my partner I was obliged to remain in Cambridge, although the Fish Commission kindly kept the steamer over at Panama for more than ten days in hopes of giving me a chance to go. But it was hopeless, and I shall have to be satisfied in working up a part of the collections, a very different thing from having had a share in securing them on the spot, and catching and observing all the accessories which give life and interest to such material.

Weismann's speculations have interested us here to a great degree, and I am desirous to see to what they will lead. We are going ahead here constantly and enlarging our facilities for the study of Natural History, and before long I hope to see nearly all the plans laid out when I first began to work here, carried out, at least so far that it will be a comparatively easy task to finish the schemes which were begun by my father, and which have grown far beyond the wildest dreams he ever could have indulged in. It has been to me a great satisfaction to have the means to do so much for science here, and if the mere administrative work of so large an establishment has crippled to a certain extent my own scientific work, I can still have the satisfaction of knowing that where I alone might have been at work, there are now a dozen in full activity. The general care of the University, which has of late years taken so great a development,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

has also materially increased my work in many directions not my own and compelled me to give a lending hand to building up other scientific departments. But in a new country, where all is to be moulded, it is no small satisfaction to feel that one is a power behind the throne for good and for evil.

I need not say how glad I was to receive your letter and to hear again from you, for I have never forgotten that it was from you that I received the first friendly recognition of one of the first papers I ever wrote, and that your kind words did much to keep me in a path which did not seem to have too many attractions for a young and ambitious student.

TO HUXLEY

CALUMET, Oct. 16, 1888.

I intended long before this to have answered your kind note, which reached me at Newport, but I have had an extended fit of laziness and have allowed myself to put off during this summer all that was not absolutely essential. The strain of last winter floored me at last and I've not been able to buckle down to work as I hoped to do at the seashore. I am here on my semi-annual visit to the mines, and the doctor has ordered me for a few weeks to the mountains in Colorado. So I am on my way to the other side of the Rockies, into what is said to be a most beautiful country just beyond the main divide of the Rocky Mountains, back of Denver and Leadville. He thinks that's all I need to start fresh, specially if I get away during the coming winter.

I was sorry to hear from Mrs. Moseley of the poor condition of Moseley's health; the poor fellow seems utterly broken down, and his chance for any more work

Digitized by Google Original from UNIVERSITY OF MICHIGAN

very poor. I hope mine is not all gone, for if the French gentlemen who have so kindly undertaken the task of special providence to the copper market will only perform that office a few years, they will enable me to carry out all the plans I ever dreamed of, before I am too old to carry them out myself. And I trust that at any rate they will enable me to go ahead within reasonable time and explore the Gulf Stream on my own account and not be dependent upon the aid of Government, which, as you know, I look upon as the worst kind of assistance. The new Fish Commissioner has tried to do his best to continue to extend to naturalists the facilities of the Wood's Hole Station, but Congress has drawn a line through the bulk of his appropriations for that purpose, and our expenditures are so well arranged that it may be the end of the summer before the money for the season is available.

The present heads of Government scientific bureaus at Washington are starting a crusade for a great National University to have its seat there. It may do very well for a beginning, but after ten or fifteen years no Professor would be anything but a political demagogue, and it would be the worst thing for science and the existing Universities — of which there are too many already — to have official science get a stronger foothold and have greater influence than it already has. It has killed all individuality in Geology, the Professors of Geology in the United States being, with few exceptions, the satellites of the Director of the Geological Survey of the United States. I hope to get back to Cambridge towards the middle of November and you may see me drop in upon you in January on my way somewhere.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

He spent the winter of 1888–89 in northern Africa, accompanied by his second son Maximilian, who, having just left Harvard, went with his father on most of his later wanderings. The two made ideal travelling companions, the calm placidity of the son acting as an excellent foil to the occasional nervous impetuosity of the father.

Agassiz's letters of this winter cover what is now such well-worn ground that, except for a few extracts, they would be out of place here; writing from Constantine, he says: "The scenery so far, from Tunis to Constantine, is pretty, but tame and not worth seeing to one who has travelled as much as I have; were I alone I should give up the whole thing at once and go home, — it's not worth the journey. But Max enjoys it immensely and he is first-rate company travelling, always cheerful and pleased and satisfied."

The following may be interesting as showing a scientific man's impression of the desert: —

BISKRA, Feb. 7, 1889.

"My visit to this place has been most satisfactory and I think I have found out what has been the former conditions of the desert, much to my satisfaction at least. I never liked greatly the various explanations which had been given of the formation of the desert, and I think I have seen the whole thing and can explain most naturally what now exists on the Sahara from what I saw along the line of the railroad, on the high plateaus, the Hondas, as they are called, on the way to Biskra. I drove this day about twenty miles into the desert to an oasis called Sidi Ocka, and on the way there got all the evidence I wanted that my explanation was at least

Digitized by Google Original from UNIVERSITY OF MICHIGAN

far more reasonable than any other I had seen, calling upon great elevation and all kinds of cataclysms to explain what seems to me a most simple thing. The whole phenomenon is very much like that which has caused our Great Salt Lake Basin and the Sinks of Nevada and Idaho and Utah and that part of the West.

I have been greatly interested in the few days I have spent here and they have fully repaid me, and I dare say if I don't see much I shall at any rate get an excellent idea of the physical geography of Northern Africa, which is certainly very different from that of any other region I have seen. The oasis here is an interesting one, and the life of the Arabs on the desert in their tents and with their herds of camels and of goats and sheep is much like what I saw on the Nile, only here they are in their element. As for the Arab villages they are all alike, mud walls, low houses, narrow streets, filthy as can be, and here and there squares planted with date palms, oranges and lemons, which relieve the scene. The Arab dress is very monotonous, — like the desert you see nothing but their gray cloaks; occasionally a gaudily dressed woman on the doorsteps with her silver bangles and rings and necklaces. The bazaars of this little place and of the Arab villages we have seen are not very gaudy, but at any rate they have not been contaminated by French influence, as at Tunis or Constantine, where they are no longer characteristic. Still even here the goods for sale are gradually becoming the very flimsiest of European make in competition with the handmade native work. There are in a store here plenty of reptiles and insects for sale, but so badly preserved that I do not care to get any."

Digitized by Google Original from UNIVERSITY OF MICHIGAN

On his return to Cambridge he writes: "I come back in good order, but how long I will remain so remains to be seen. I greatly fear that I have reached the stage where I am well only when I do nothing, and that is not a very agreeable prospect for an active individual like me."

In the fall, Agassiz was offered charge of the section of Marine Zoölogy on the U.S.S. Pensacola, which conveyed the U.S. Eclipse expedition to West Africa, the idea being to dredge from the Equator to the Cape, while the astronomers were at work on land. Unfortunately, he was asked to join the expedition at so late a date that he found it impossible to fit out the vessel in time unless he could transfer the Blake equipment to the Pensacola; this, owing to red tape, he was unable to do.

TO HUXLEY

CAMBRIDGE, Jan. 14, 1890.

We were very sorry not to be able to have your son to stay with us while he was in Cambridge. But I have been laid up with a most obstinate fever since the beginning of December and am only allowed now to see one or two people and to write an occasional note. Fortunately, your son fell into good hands and I hope he will be able to do what he has planned. But it needs good backing from a few rich parents in New York, and with that he is safe. Most of the schools, such as he proposes to establish, are under the wing of some denomination, but there is plenty of liberal spirit to support an entirely unsectarian affair.

My fever has upset all my plans for work for this winter. I came back from the West feeling particularly well and hoped for a steady working winter. I was specially interested in working up the material of a most

Digitized by Google Original from UNIVERSITY OF MICHIGAN

interesting new stalked Crinoid, closely allied to Apiocrinus, and one of the most interesting finds from the deep sea. It was collected by the Albatross — Fish Commission steamer — off one of the Galapagos. Of course all this is hung up to my great disgust, and the doctor says it will be fully a month before I can hope to be at work regularly again.

I was glad to hear you had cast the dust of London from your feet and were quite well again in your new home in the country and able to do quite as much work as you like. By the way, a few days before I knocked off work, Murray wrote me he should only publish one more volume of the Challenger, and a supplementary number containing your Memoir on Spirula. If you have quite done with my specimen I should be glad to have it again. The best way of shipping it would be to put the bottle in a small box and leave it at the London office of the Cunard Line, asking them to send it to *Boston* by their first steamer.

By the spring of 1889, the façade of the Museum building had been completed, with the exception of the corner piece. Except for the sections of botany and mineralogy, built by subscriptions collected with Agassiz's help by Professors Goodale and Cooke, nearly all the building and the publications, as well as most of the collections in the Museum of Comparative Zoölogy proper, had been, since the death of his father, at Agassiz's expense.

Dr. Brown-Séquard, an old friend of the family, in writing to Agassiz about this time says: "I am very glad, indeed, that you are carrying out so fully the grand ideas of your father as regards the Museum. When you

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

have accomplished that great work, Cambridge will be a unique place in the world for such a *natural* systematic display of the animal creation. When steamships can cross the Atlantic in four days, I expect that European Naturalists will go and study your father's plans and views as exhibited in this Museum, whose existence will be due to your exertions and liberality."

It had always been Agassiz's aim to build up a museum that would above all things furnish facilities for original investigation and advanced work, and his efforts were constantly directed toward that end. It was now becoming apparent that the resources of the Museum were being more and more absorbed in undergraduate instruction, for which they were never intended. This often led him to take a dark view of his work for the Museum, and to wish that the time he had spent in its interests had been used in other directions. Such feelings grew with the advancing years, and his correspondence abounds in passages similar to the following extract from a letter of somewhat later date to Professor F. Jeffrey Bell, of the British Museum: —

"Since Fewkes left the Museum we have had no specialist for Radiates, and hence all I can send you is a small piece of Titanideum suberosum from Stono Inlet, South Carolina. I picked this off from one of the specimens on exhibition. I don't quite see what is to become of us. I am sick to death of supplying the means of running a big machine, when I have so much better use for them in explorations and publications. After twenty years of playing a lone hand, I shall some fine day clear out and burn my ships behind me. I have no doubt there is no end of this material in the Museum

Digitized by Google Original from UNIVERSITY OF MICHIGAN

(Titanideum), but there is not a single person who knows the Alcyonarians enough to pick out anything, and I am out of the question for any such work. Sorry to treat you so shabbily."

With all his varied interests he had found time to devote himself to his *Alma Mater* in many ways besides looking after the Museum. When Professor Pickering was appointed Director of the Observatory, Agassiz raised a fund which served as the basis of establishing the department of Astronomy on its present footing. And it was through his influence that the generosity of Mr. T. J. Coolidge took the form of founding the Jefferson Physical Laboratory.

From 1878 to 1884, Agassiz had been a member of the Corporation, a body that controls the affairs of the University. He resigned on the plea of not being able to devote sufficient time to its duties, but in 1886 he again accepted the position, feeling he could not resist the pressing invitation to serve once more. Of his appointment he writes: "I hope you will not pitch into me for having rejoined the Corporation. The fact is, I could not say no. I have got through my Blake—Calumet responsibility is well off my hands through Mr. ——; I am getting too old to do much more work of my own, and this is the simplest way of helping others and doing my share of public work in something I know all about."

It will be noticed that the man who accepted the position on the Corporation because he was too old to do much more work of his own had still most of his scientific expeditions ahead of him; and as for Calumet responsibility being well off his hands, he writes from

Digitized by Google Original from UNIVERSITY OF MICHIGAN

there about this time: "I am as usual taking time by the forelock, and looking ahead a few hundred years and laying out more work. It will soon pay the Calumet stockholders to pay me $100,000 a year to stay at home!! I am going underground to-day and to-morrow, and on what I see will depend plans for the future."

During Agassiz's connection with the administration of Harvard his efforts were directed toward moulding it more on the lines of a German university. He was especially interested in attempting to remedy what is still to-day a crying evil in most of our American universities, the lack of their professors of sufficient time for research work. So strongly did he feel in this matter that, under certain conditions, a considerable portion of his estate may eventually revert to the founding of research professorships in connection with the Museum. He also exerted his influence toward abolishing a classical education as the only and compulsory method of obtaining a degree; but he was one of the first to regret that a liberal curriculum led more and more to the introduction of technical instruction in the older universities, a danger which was clearly pointed out to him by Charles Eliot Norton.

TO C. E. NORTON

A few days ago I received the rank list of the Freshman Class and find it as I expected a fine example of the working of the present rules of the College Faculty.

B——, for example, stands on the rank list in six out of nine subjects, and well up in three of them, but he is notified he cannot get his degree if he does not get a certain per cent in Greek.

If a boy's work is to be judged by percentages, let

Digitized by Google Original from UNIVERSITY OF MICHIGAN

him at least get the benefit of it in the things in which he does well. The present system is eminently calculated to discourage a boy from doing well in any one thing; if he can scrape through poorly in all, he is safe. If he has a taste for a study and does remarkably well, then it is useless unless he can manage to do a certain amount in something for which he may be totally unfitted. I most decidedly object to any one department, I do not care what it is, laying down the law as is now done that unless a boy does such a per cent in a study he shall not get his degree, and if he does not do well in a couple, he may be dropped. In the present state of learning this is an intolerable assumption, and one which is sure to react on Cambridge by leaving the men who are educated there entirely out of the tide of what is going on, and tending to make prigs of them. It will most assuredly tend to alienate the good will of the friends of the college, if they find that the regulations are such that they cannot educate their sons (of average capacity) there unless they manage to imbibe something which they cannot possibly assimilate. We want to find out what is in a boy and give him a chance to show it. We do not want to judge him by what he cannot do, but by what he accomplishes. He is measured so in after life, and he must be the judge of the course he takes.

The sooner the educators of the country recognize the fact that at 16 to 18 a boy's brain will do some things and not others, the better; and furthermore that all brains are not alike and never will be, and cannot up to that time be developed alike, nor in the same direction.

A boy who shows aptitude in one line of study ought to have the chance to remain in Cambridge and get his degree. This is eminently just. Comparatively recently

Digitized by Google Original from UNIVERSITY OF MICHIGAN

all that was required was the literary side of education for such a degree. I now ask that the scientific side have the same chance. I do not want to interfere in any way in that direction, but I do not want the literary side to dictate terms, which if dictated by the scientific side would deprive nine tenths of the students of their degree, and yet we might not be asking more than you think every well-educated man should know.

This is to me a most serious matter. I have fought in vain to obtain recognition thus far; but those who feel as I do are numerous, they are many of them warm friends of the college, and something must be done to satisfy one half of the patrons of the college.

Excuse this long epistle, it may be worded somewhat dogmatically, but I must acknowledge that since I have had anything to do with college matters I have never felt so hopelessly helpless as when attempting to attack the circumlocution office of Faculty — Overseers — Corporation.

Agassiz frequently said that the idea that a classical education was the only education was a survival of the days when, if a boy was to be taught anything, the only people who could do it were the monks who knew nothing but the dead languages. He did not deny the value of a classical training, but maintained that an equally good one could be given by other methods, to boys whose tastes lay in different directions; and greatly resented the assumption of the classical scholar, who calmly assumed that the scientific man was uneducated unless he was on familiar terms with the classics, while he himself was most probably ignorant of the causes of the simplest things happening about him.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

In 1890, finding himself more than ever out of sympathy with the administration of the University, feeling that his influence had not accomplished what he had hoped, and especially that the wider interests of the University were being sacrificed to the undergraduate department, he again tendered his resignation from the Corporation. In a letter to his old friend, Mr. John Quincy Adams, also a member of the Board, explaining his reasons for this action, Agassiz says: "I might go on indefinitely, and show you that we are very nearly at the same stage as when we began to take an interest in the College. That is the discouraging part for a man who is accustomed to accomplish something."

TO CHARLES W. ELIOT

NEWPORT, June 1, 1890.

While I fully appreciate the consideration shown me by the Corporation in laying on the table my proposition to be on the lookout for my successor, and will not press my resignation at this moment, it does not change my view of the position. It is impossible for me to be hereafter much more than a dummy in the Corporation. I am carrying altogether too much sail, and am unfortunately too much of a foreigner to take things as they come, and cannot help taking things to heart so far as to produce a state of mind wasteful in the extreme, both of energy and time. I have allowed my interest in Cambridge completely to overshadow my own plans and have been drawn little by little into a position which is no longer tenable. Put yourself in my place.

1. I am expected to run the largest Department of the College with the exception of the Observatory.

2. To supply the means practically for doing this.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

3. To run the machine which gives me the means of so doing.

4. To carry on my own scientific work.

Most men are satisfied to do any one of 1, 3, 4, and you must add the Corporation to this. It is true I have stopped 2, practically. But to carry on my own scientific work I must of necessity continue in charge of 3 (Calumet). I must find relief somehow, and the only thing to do at my age is to withdraw from the Corporation — and do the same from the Museum as soon as it is free of debt, and a suitable Curator can be found, or as soon as my plans are matured for leaving Cambridge, making my steamer my headquarters for the winter and Newport for the summer. I have done my share for the public and propose now to retire and do a little at least of what interests me most.

Notwithstanding the amount of time, from 1881 to 1890, which Agassiz devoted to the executive work of the mine, the Museum, and the University, to say nothing of his enforced winter absences in search of health, his writings during that period number no less than fifty-nine titles. While many of these were of course short articles, some of the more important publications were "Three Cruises of the Blake," — "Blake Echini," "Coral Reefs of the Hawaiian Islands," and a number of papers on the embryology and development of bony fishes.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

CHAPTER XI

1891

THE FIRST ALBATROSS EXPEDITION

Agassiz had always been most anxious to supplement his work on the Blake in the Caribbean, by an expedition in the Panamic region of the Pacific. For it was well known that the littoral fauna of these two localities bore a striking resemblance. This led him to believe that a comparison of the deep-sea forms on the Pacific side of the Isthmus of Panama with his old friends in the Caribbean would furnish reliable data for some most interesting conclusions. If he could establish geologically the approximate period at which the Caribbean ceased to be a bay of the Pacific, he hoped to be able to determine the amount of change that had taken place between the deep-sea fauna on each side of the Isthmus, since the passage connecting them had ceased to exist.

Already he had been twice disappointed in his hope of undertaking such an expedition. In 1879, he was invited by Admiral Belknap to join his flagship off Panama and undertake a deep-sea cruise; unfortunately the breaking-out of the war between Peru and Chile made this expedition impossible. Again in 1888, business matters prevented his accepting an invitation to join the Albatross at Panama, on her way from New York to San Francisco.

In 1890, he was asked by Colonel Marshall MacDonald, the United States Fish Commissioner, to take charge of

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

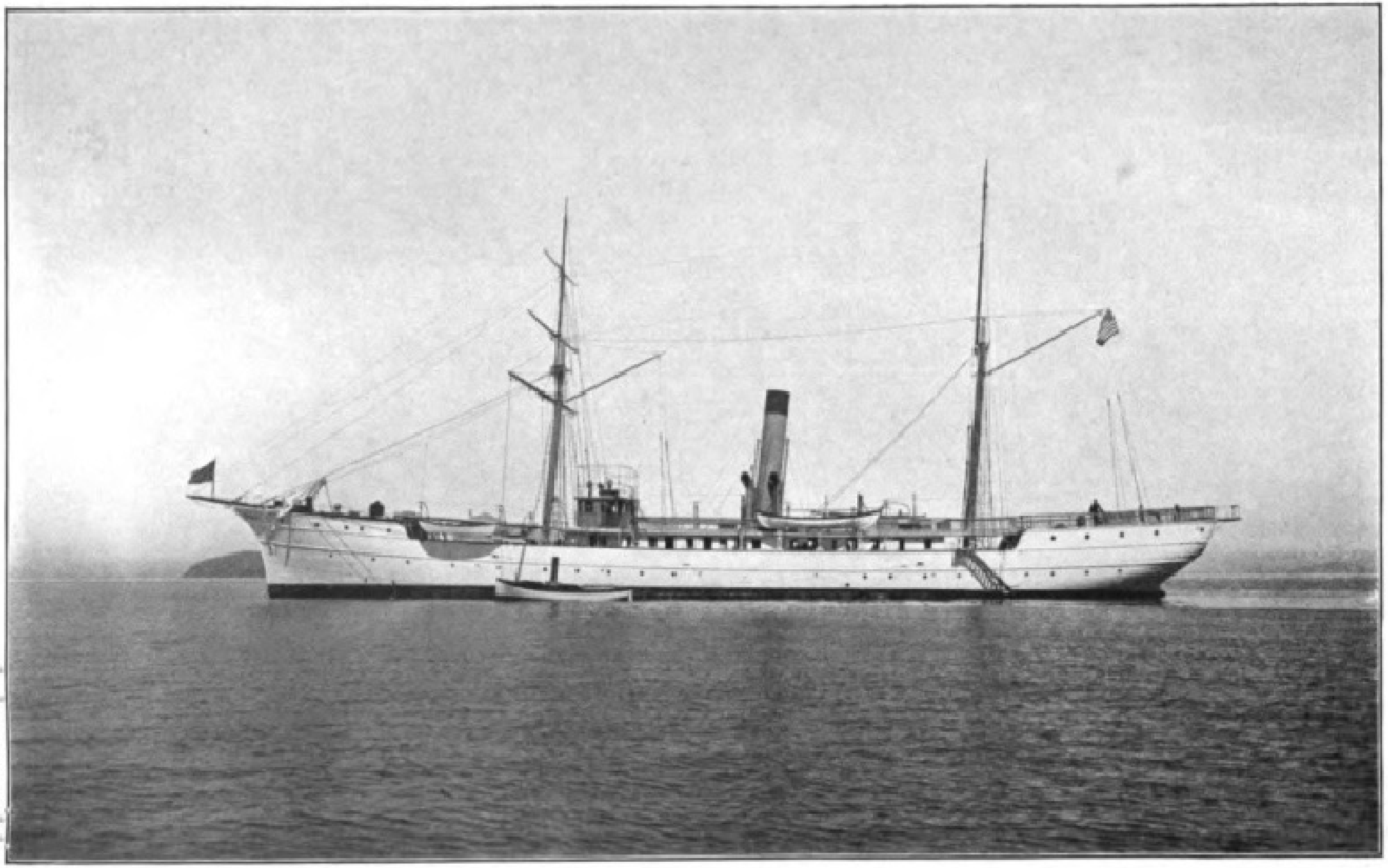
a deep-sea expedition off Panama the following year in the Albatross. The conditions under which Agassiz was offered the ship included his supplying the coal, assisting in thoroughly reëquipping the boat, and paying part of the running expenses. In return he was to get a first set of the collections which especially interested him. The result of the arrangement was, that this and his subsequent expeditions in the Albatross were little if any less expensive to him than the expeditions he undertook later without government aid.

The Albatross was built in 1882 especially for the use of the United States Fish Commission. She was 234 feet over all, 200 feet on the water-line, with a beam (moulded) of 27 feet 6 inches. At 12 feet draught, she displaced a trifle under 1100 tons. Her engines had an indicated horse-power of a shade over 450, and she was fitted with twin screws. She was furnished with a very complete marine laboratory; and when reëquipped for this expedition possessed all the most approved devices of the day for the investigation of the ocean. Her officers were detailed from the United States Navy; her captain, Lieut.-Commander Z. L. Tanner, having been in charge ever since her first cruise. From 1883 to 1886, she worked for the Fish Commission along the Atlantic coast. In 1887, she left for the Pacific, sounding and dredging along her route; and in 1890, she was sent to Bering Sea to investigate the seal fisheries.

In January, 1891, with the consent of the President, the Albatross was ordered to Panama. Agassiz left New York on February 10, taking with him Mr. Magnus Westergren, who was to act as artist of the expedition.

On reaching Panama, after crossing the Isthmus, where the French were at work on the canal, he writes: —

Digitized by Google Original from UNIVERSITY OF MICHIGAN



THE ALBATROSS

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

"It seems quite natural for me to be here again in the same old hotel where I have so often stopped and with the same landlord who was here in 1859, when I first passed through on my way to California, and who has been here ever since. He seemed quite pleased to see me again and has made me as comfortable as one can be in a combination of a French-Spanish mansion.

"The canal can be fairly seen from the line of the railroad, and it is really frightful to see the waste; the whole length of the line is one long village, houses for the men, and all along you find dredges by the half-dozen laid up and going to pieces, and in a few localities every ten miles or so there is an entrepôt with miles of machinery, much of which has never been used, and no less than six large steamers have returned to Europe filled with the wrecks which could be still used elsewhere. There has been much less work done than I imagined, judging from the money spent; it was generally supposed that nearly one-third was done, but I hardly think there is one-tenth of the work finished. They have, it is true, some twenty-five miles of canal in the plains at the two ends well advanced, but the real work of cutting consists only of a few scratches, nowhere more than twenty feet below the railroad!

"I go on board the Albatross this P.M., and we start to-morrow. The working accommodations are fine, an upper room twenty by twenty for rough work and general laboratory, and a second floor below for storing the collection in racks — we ought to do well. My cabin is nine by eight; I have a closet to hang things, about twelve good-sized drawers under my bunk and in a bureau, and I keep one of my trunks to stow away stuff, a couple of shelves and hooks, and you have my equip-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

ments. My cabin opens out into a good-sized dining-room and sitting-room of about twelve feet by the width of the ship, where Tanner and I sit and take our meals. It has large portholes, a fine skylight, and is very airy and comfortable. Strange to say, it has the desk and sideboard which were on the Hassler when Father made his trip from New York to San Francisco in 1871–72!"

The first trip (see Chart 2 in the back cover) was a sort of preliminary trial to test the apparatus; the ship left Panama on February 22, and returned after an absence of twenty days. On leaving Cape Mala, which marks the western entrance to the Bay of Panama, she proceeded to Cocos Island, over four hundred miles to the westward, and from there made a broad sweep to Malpelo Island, about three hundred miles to the eastward, and back to Panama. Some idea of what was done on the initial cruise can be gathered from a letter to the Fish Commissioner, written after reaching Panama.

TO MARSHALL MACDONALD

ON BOARD THE ALBATROSS,
March 14, 1891.

I have found, in the first place, a great many of my old West Indian friends. In nearly all the groups of marine forms among the Fishes, Crustacea, Worms, Mollusks, Echinoderms, and Polyps, we have found familiar West Indian types or East Coast forms, and have also found quite a number of forms whose wide geographical distribution was already known, and is now extended to the Eastern Pacific. This was naturally to be expected from the fact that the district we are exploring is practically a new field, nothing having been done except

Digitized by Google Original from UNIVERSITY OF MICHIGAN

what the Albatross herself has accomplished along the west coast of North and South America. The Challenger, as you will remember, came from Japan to the Sandwich Islands, and from there south across to Juan Fernandez, leaving, as it were, a huge field of which we are attacking the middle wedge. As far as we have gone, it seems very evident that, even in deep water, there is on this west coast of Central America a considerable fauna which finds its parallel in the West Indies, and recalls the pre-Cretaceous times when the Caribbean Sea was practically a bay of the Pacific. There are, indeed, a number of genera in the deep water, and to some extent also in the shallower depths, which show far greater affinity with the Pacific than with the Atlantic fauna. Of course, further exploration may show that some of these genera are simply genera of a wider geographical distribution; but I think a sufficiently large portion of the deep-sea fauna will still attest the former connection of the Pacific and the Atlantic.

I am thus far somewhat disappointed in the richness of the deep-sea fauna in the Panamic district. It certainly does not compare with that of the West Indian or Eastern United States side. I have little doubt that this comparative poverty is due to the absence of a great oceanic current like the Gulf Stream, bringing with it on its surface a large amount of food which serves to supply the deep-sea fauna along its course. In the regions we have explored up to this time, currents from the north and from the south meet, and then are diverted to a westerly direction, forming a sort of current doldrums, turning west or east or south or north according to the direction of the prevailing wind. The amount of food which these currents carry is small com-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

pared with that drifting along the course of the Gulf Stream. I was also greatly surprised at the poverty of the surface fauna. Except on one occasion, when during a calm we passed through a large field of floating surface material, we usually encountered very little. It is composed mainly of Salpæ, Doliolum, Sagittas, and a few Siphonophores,—a striking contrast to the wealth of the surface fauna to be met with in a calm day in the Gulf of Mexico near the Tortugas, or in the main current of the Gulf Stream as it sweeps by the Florida Reef or the Cuban coast near Havana. We also found great difficulty in trawling, owing to the considerable irregularities of the bottom. When trawling from north to south, we seemed to cut across submarine ridges, and it was only while trawling from east to west that we generally maintained a fairly uniform depth. During the first cruise we made nearly fifty hauls of the trawl, and in addition several stations were occupied in trawling at intermediate depths. In my dredgings in the Gulf of Mexico, off the West Indies, and in the Caribbean, my attention had already been called to the immense amount of vegetable matter dredged up from a depth of over fifteen hundred fathoms, on the lee side of the West India Islands. But in none of the dredgings we made on the Atlantic side of the Isthmus did we come upon such masses of decomposed vegetable matter as we found on this expedition.

Cocos Island is only about two hundred and seventy-five miles from the mainland, and its flora, so similar to that of the adjacent coast, tells its own story.[1] Malpelo, on the contrary, which is an inaccessible rock with vertical sides, and destitute of any soil formed from the disinte-

[1] See page 255, second paragraph.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

gration of the rocks, has remained comparatively barren, in spite of its closer proximity to the mainland.

The most interesting things we have found up to this time are representatives of the Ceratias group of Fishes, which the naturalists of the Albatross tell me they have not met before on the west coast of North America. The Crustacea have supplied us with a most remarkable type of the Willemœsia group. The paucity of Mollusks and also of Echini is most striking, although we brought up in one of the hauls numerous fragments of what must have been a gigantic species of Cystechinus, which I hope I may reconstruct. We were also fortunate enough to find a single specimen of Calamocrinus off Morro Puercos, in seven hundred fathoms, a part of the stem with the base, showing its mode of attachment to be similar to that of the fossil Apiocrinidæ. The number of Ophiurans was remarkably small as compared with the fauna of deep waters on the Atlantic side, where it often seems as if Ophiurans had been the first and only objects created. The absence of deep-sea corals is also quite striking. They play so important a part in the fauna of the deeper waters of the West Indies, that the contrast is most marked. Gorgoniæ and other Halcyonoids are likewise uncommon. We have found but few Siliceous Sponges, and all of well-known types. Starfishes are abundant, and are as well represented in the variety of genera and species as on the Atlantic side of the Isthmus. I may also mention the large number of deep-sea Holothurians (Elasipoda) which we obtained, as well as a most remarkable deep-sea Actinian, closely allied to Cerianthus, but evidently belonging to a new family of that group. We found the usual types of deep-sea West Indian Annelids, occasionally sweeping

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

over large tracts of mud tubes in the region of green mud. Although we dredged frequently in most characteristic Globigerina ooze, I was much struck with the absence of living Globigerinæ on the surface. Only on two occasions during a calm did we come across any number of surface Globigerinæ and Orbulinæ. On one occasion the trawl came up literally filled with masses of a species of Rhabdammina closely allied to R. lineata. Thus far no pelagic Algæ have been met with.

I can hardly express my satisfaction at having the opportunity to carry on this deep-sea work on the Albatross. While of course I knew in a general way the great facilities the ship afforded, I did not fully realize the capacity of the equipment until I came to make use of it myself. I could not but contrast the luxurious and thoroughly convenient appointments of the Albatross with my previous experiences. The laboratory, with its ingenious arrangements and its excellent accommodations for work by day and night, was to me a revelation. Mr. Westergren has found his time fully occupied, and we have in this trip brought together a considerable number of colored drawings, giving an excellent general idea of the appearance of the inhabitants of the deep waters as they first come up. These drawings can be used to great advantage with the specimens in making the final illustrations to accompany the reports of the specialists who may have charge of working up the different departments.

While coaling and making some slight repairs he writes: —

"The Albatross is an excellent sea boat and she rides the sea wonderfully well, and really much better than

Digitized by Google Original from UNIVERSITY OF MICHIGAN

many a large ocean steamer I have been on. We have done about as much work these eighteen days as I did on the Blake on my first cruise. You can have no idea how comfortable the trip has been. The quarters I share with the Captain are very spacious and in this hot weather it makes a great difference not to feel cramped. The accommodations for work and for taking care of the collections are excellent. There are two men to help to put them aside, a Mr. Townsend, who is called the naturalist of the ship and who is the most obliging and hard-working man imaginable, and a Mr. Miller, the chemist, who gets all the needed preparations ready and also helps to put up the things, so that I have a chance to spend what time there is between the dredgings and, while the things are being sorted, to examine them and make notes and superintend Westergren. We shall hardly get away from here before the 20th, as there are two ships ahead of us for coal and our repairs may take the greater part of the time till our turn comes. While coaling ship I shall live on shore and go on line of the railroad with the doctor of the old Canal Company. I have also an invitation to spend the day at the plantation of a Mr. Erman, who is the principal banker here. This plantation is about fifteen miles from Panama near one of the most interesting parts where the work was done on the Canal. He seems to have seen a good deal of Father and of the Hassler people while they spent three weeks at Panama, and says I shall find on the plantation a good many people who are old acquaintances of the Hassler. Captain Tanner has been perfectly indefatigable; he is indeed a model Captain for such a trip. We begin at 5 A.M. and keep it up till 10 P.M. My patent intermediate net was a fail-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

ure, but Captain Tanner and I rigged up a new machine which has worked to perfection and shows plainly that there is *no intermediate fauna* as I have always stuck to. But using the net deep down just above the bottom, say one hundred fathoms, I have brought up some interesting things, and have also found some *good things* by towing at two hundred fathoms only in deep water and have caught as surface things, which go down in the day or when it blows, many of the so-called deep-sea things."

On leaving Panama for the second time, the Albatross proceeded to Galera Point, about four hundred miles from Panama Bay, on the coast of Ecuador; from here she ran a line across the Humboldt Current as far as the south face of the Galapagos, something over five hundred miles to the westward of Galera Point. After visiting the islands the ship worked her way to Acapulco.

When once well out at sea the work of the expedition settled down to its regular routine. The day's programme began with a sounding, often before six, but sometimes, after a hard day, it was not taken till the change of the watch at eight o'clock. Then the whirr of the machine on the poop deck overhead could be heard buzzing away merrily while Agassiz and the Captain were at breakfast. As soon as the bottom sample, a tube full of abyssal ooze, reached the surface, it was taken to the laboratory amidships. While Agassiz was examining this, the great dredging boom was swung out to starboard, the big Blake trawl was lowered away, and the ship lay to while the three or more miles of wire rope sometimes necessary to drag it along the bottom was slowly paid out; then the vessel steamed ahead

Digitized by Google Original from UNIVERSITY OF MICHIGAN

slowly, while Agassiz occasionally left his work in the laboratory to note the strain on the tackle recorded on a dial. After a time the vessel was again stopped, and the long tedious process begun of reeling in what appeared to be an endless line of cable. The incessant monotony of the *clank, clank*, of the reeling engine was punctuated by an occasional sharp vibrating jar, as a sudden roll of the ship brought an extra strain on the gear. Meanwhile in the laboratory, Agassiz and his assistants were busy sorting what remained of the hauls of the previous day, preserving the specimens and preparing them for storage in the racks in the lower laboratory.

As soon as the catch arrived on board, all was bustle, activity, and excitement. The contents of the bag, a mass of ice-cold ooze, was turned into sieves and washed down under spray, while Agassiz, eager as a boy, inspected each fresh revelation from the silent depths of the sea. Again the work of sorting and preserving the specimens continued under Agassiz's supervision in the laboratory, some of the more delicate being turned over to Westergren to sketch. There were usually three or four dredgings a day. Often the last haul did not come on board till after dark, sometimes as late as ten or eleven o'clock, when they were handled by the help of the deck lights.

While the trawl was dragging slowly over the bottom, a surface tow net was sent overboard on one of the lower booms. If this haul proved interesting, the ordinary routine would be interrupted, and the huge intermediate tow net, substituted for the trawl, would be sent down, often three or four times, if the surface towings showed abundance of life.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

On very still nights the surface net was in use till late into the night, while Agassiz examined, in glass bowls held directly over an electric light, the catch of minute pelagic forms. At every anchorage electric lights were put into the water at night to attract the surface fauna. This furnished sport for the sailors, who fished up the prey with long-handled gauze dip nets. Agassiz's attentive consideration of all the specimens brought to him by the men served to keep up their interest, and the amount of pelagic material thus collected was considerable.

After reaching the Galapagos, writing to Colonel MacDonald of the line across the Humboldt Current he says: "With the exception of three good casts the trawling on that part of the sea bottom proved comparatively poor."

He must, however, have been thinking at the time of some of the wonderfully rich ground he had dredged in the Blake, for the letter continues: —

"In the deeper parts of the channel between Galera Point and the southern face of Chatham Island we found a great number of Elasipoda, among them several genera like Peniagone, Benthodytes, and Euphronides, represented by numerous species. The Starfishes of this our second cruise did not differ materially from those collected during our first trip, but we added some fine species of Freyella, Hymenaster, Astrogonium, Asterina, and Archasteridæ to our collection. Among the Sea-urchins on two occasions we brought up fine hauls of a species of Cystechinus with a hard test, many specimens of which were in admirable state of preservation." And so on through a list of the Ophiurans, Gorgonians, crustaceans, worms, mollusks, fishes, etc.

Digitized by Google Original from UNIVERSITY OF MICHIGAN



EMPTYING THE TRAWL

U of M

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

"Arriving as we did at the Galapagos at the beginning of a remarkably early rainy season, I could not help contrasting the green appearance of the slopes of the islands, covered as they were by a comparatively thick growth of bushes, shrubs, and trees, with the description given of them by Darwin, who represents them in the height of the dry season as the supreme expression of desolation and barrenness. Of course here and there were extensive tracts on the seashore where there was nothing to be seen but blocks of volcanic ashes, with an occasional cactus standing in bold relief, or a series of mud volcanoes, or a huge black field of volcanic rocks, an ancient flow from some crater to the sea; but as a rule the larger islands presented wide areas of rich fertile soil, suitable for cultivation.

"The course of the currents along the Mexican and the Central and South American coasts clearly indicates to us the sources from which the fauna and flora of the volcanic group of the Galapagos has derived its origin. The distance from the coast of Ecuador (Galera Point and Cape San Francisco) is in a direct line not much over five hundred miles, and that from the Costa Rica coast but a little over six hundred miles, and the bottom must be for its whole distance strewn thickly with vegetable matter. The force of the currents is very great, sometimes as much as seventy-five miles a day, so that seeds, fruits, masses of vegetation harboring small reptiles, or even large ones, as well as other terrestrial animals, need not be afloat long before they might safely be landed on the shores of the Galapagos. Its flora, as is well known, is eminently American, while its fauna at every point discloses its affinity to the Mexican, Central, or South American and even West Indian

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

types, from which it has probably originated; the last indicating, as well as so many of the marine types collected during this expedition, the close connection that once existed between the Panamic region and the Caribbean and Gulf of Mexico."

Continuing his line along between Chatham and Indefatigable Islands, Agassiz was disappointed in his poor hauls: —

ON BOARD THE ALBATROSS,
INDEFATIGABLE ID., April, 1891.

"Here we are at anchor in Conway Bay on the west end of Indefatigable Island, having done all we can afford to do at the Galapagos. We spent nearly three days at Chatham Island, which is the island where a man by the name of Cobos has been having a farm since '67; up to a couple of years ago he worked it with convicts, but they gave so much trouble and it was so dangerous for him and his family that he applied to the Ecuadorian Government to remove them, and now has regularly paid workmen, a colony of about three hundred including women and children. He has now laid out quite a large cattle ranch, about twenty thousand head of cattle, a large sugar plantation, a coffee plantation, and a huge vegetable garden. He salts his meats and carries on also an extensive fishery, sending all his plunder to Guayaquil. He hâs a small trading schooner which goes during the season about once a month to the islands. It was quite funny to find Baur's[1] letter had just reached him, a few day before we got there, by an Ecuador man-of-war, which had been sent evidently to watch us, they thinking the United States

[1] The naturalist, Georg Baur, then visiting the Galapagos.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Government had some views on the islands connected with the Canal at Panama or Nicaragua! We paid him (Cobos) a visit to his hacienda about six miles from where we were at anchor. He promised to send mules to meet the crowd, but, true Spanish fashion, after we waited for two hours, we decided to start to walk. It had got pretty hot by that time, and the road was nearly impassable from the rain. It is the hot rainy season here now, so you can easily imagine the spectacle presented by the officers after an hour of walking up to our knees in mud in a broiling sun. But at last we met the mules and cooled down toward the last part of the trip. We took lunch in the most primitive manner. Everything very good, but no comforts of any kind, and dirty beyond description. We sauntered round the village of workmen, a most interesting sight in the way of social economy, and took some fresh mules to ride over the greater part of the island. It is really quite pretty when you get up well along the mountain-side, about two thousand feet, and pass above the tangle of cactus and mimosa, which makes the lower slope of the island nearly impassable.

The doctor of the ship was most busy during our stay. He had all the ills of the population to attend to, for there is no physician settled on the plantation! The men shot a good lot of birds, and Mr. Townsend has been a most hard-worked man skinning the plunder. I spent my time on shore collecting rocks, botanizing, and catching insects, and it seemed quite natural to be going round again with a butterfly net. After endless delays we succeeded at last in getting our provisions on board and sailed for Charles Island. That has an old abandoned plantation, the first of the islands where the

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Captain wanted to give the men shore liberty to fish, bathe, and get all the fruit they wanted, as there were no liquor shops in the way. We stayed there one day; the men had their fill, and I spent my time much as I did on Chatham.

Next we went to a small island called Duncan, hoping to get a lot of the gigantic land tortoise and lizards peculiar to the island. We found plenty of the latter, but only got one of the former; this I was sorry for, as I depended upon our catch to fill up the Galapagos Islands group in the Pacific Exhibition Room. Still I think the Hassler brought some turtles, and I will have Garman make an exhibit of the reptiles of the group anyway. Townsend is to give me a set of the birds, so that we can make a show at least in the space reserved for oceanic islands in the Pacific Room. At Duncan, I spent the day tramping, hoping to get a turtle or so, but only got very warm and greatly enjoyed the bath at the end of the day in a beautiful clear coral beach where I paddled round until I got well cooled. After dark we steamed to Indefatigable where I write this, and shall start early to-morrow on our regular dredging trip again, and nothing ought to interfere to keep us from dredging to our hearts' content from here to Acapulco."

Shortly before reaching Acapulco he continues: —

"Here we are within three hundred miles of Acapulco, and a more disgusted individual it would be difficult to find. After leaving Indefatigable Island we began to dredge; and I fondly hoped on the weather side of the Galapagos to find a very rich fauna and to make splendid hauls. But time after time the trawl came up

Digitized by Google Original from UNIVERSITY OF MICHIGAN

with about a pint of most uninteresting specimens, or else it came up torn to pieces, as the lava bottom played havoc with the nets, and so it kept up till we left Culpepper Island, the most northerly of the islands; and I hoped that at least on the sea bottom of the deep basin, when out of the influence of the lava fields of the islands, we should get some good deep-water hauls. But there again, that part of the Pacific proved as barren as the rest, and the piece of sea I had been congratulating myself that the Challenger left for me, has been a great disappointment. We still have the chance off Acapulco, now when within sight of land, to get something on the continental slope. I settled, however, once for all the fact that below two hundred fathoms at sea there was no animal life, and the pelagic people will now have to stop sailing into me, and take a back seat. Day before yesterday we struck a regular trade-wind blow and I was as sick as I could be, and as luck would have it I could not find my Leavitt seasick pills, so made myself as comfortable as I could. Of course no work could be done, and yesterday the weather moderated for us to work again and my stomach resumed its usual placidity. It's funny what things you wish to eat while trying to get well. I managed to eat a little pineapple, some fried bananas, and sour-krout! It seems a queer combination, but worked admirably and kept me well alive."

On their arrival in Acapulco he writes: —

"We are in the midst of coaling, and a more filthy place than the Albatross is just now, you cannot imagine. I begin to realize what I escaped at Panama. I have not gone ashore here to live because the hotel is such a frightful hole that even I, accustomed as I am

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

to Spanish ways, could scarcely stand it. We spent yesterday making official calls to the Governor of the Province and the Captain of the Port. The former is a very fine specimen of a Spaniard. He was with Diaz in the defense of Puebla, made prisoner, escaped from the French, and is in every way a very interesting man, well educated, speaks French and English, and has a very good-looking and pleasant daughter educated in San Francisco.

"I see you have also the common idea that Panama is deadly and the climate frightful. The whole thing is a mistake and if people who go there will observe the ordinary precautions, there is not the least danger."

TO MRS. C. L. PEIRSON [1]

ACAPULCO, Apl. 13, 1891.

We arrived here last night, and among other letters I was pleased to find two from you. I expect from your many dissipations to find you and Charlie quite poorly — it seems funny to think of anybody's going to dine! I hear a good deal about grub on board, but nothing of the kind that could be called a dinner by our friend Ward McAllister. I think I shall quite enjoy a good dinner served with some style, but it does not look as if I should get one very soon, for I shall have to trot to Calumet soon after reaching Cambridge and see if there is anything left to pay for the coal bills of the Albatross. We are just laying in two hundred tons, at twenty dollars, and have had that pleasure twice before at Panama, so I feel quite poor. This is quite a quaint mediæval place, has not changed an atom from the time it used to be the great rendezvous of the Spanish gal-

[1] His sister-in-law.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

leons sailing from Manila and sending their treasures overland to Vera Cruz for old Spain. Fort San Diego looks much as it must have in those days, and is of course to-day perfectly useless. It seems strange to me to be here again. I spent six weeks here in '59, a young chap with my whole life before me, and I remember very distinctly the week I passed here again on my way home to be married; it seems only yesterday. Little did I dream in those days of what I should have to go through. I had everything to live for then, and it has been pretty uphill work for a long time. But I ought not to complain, or at least the world does not think so. I have been in all I have undertaken most successful from the world's point of view, but from mine it has lost its charm long ago.

My trip is now drawing to a close. We sail day after to-morrow and should reach Guaymas the 25th. Then I shall leave the Albatross and shall not be sorry to be wending my way homeward. This will make nearly three months at sea, and that is quite enough for one season. I have, however, been most comfortable. The officers have done all they could to make the cruise a success, and I shall have accomplished a project I had almost given up. It has not been quite what I anticipated, but has amply repaid me for the time spent.

On leaving Acapulco the cruise continued up the Gulf of California; since the character of the bottom, as given on the charts, indicated nothing different from what had been dredged off the coast of Acapulco, the ship steamed as far as Cape Corrientes without making a haul. Here they brought up nothing but mud and decayed vegetable matter, so they kept on up the Gulf

Digitized by Google Original from UNIVERSITY OF MICHIGAN

of California till off the Tres Marias. Here some good hauls were made, though the character of the bottom did not change materially as the Albatross went farther north into the Gulf. They found the trawling most difficult from the weight of mud brought up in the trawl, but occasionally a rich haul more than repaid them for the less productive ones.

"Two of the hauls are especially worthy of mention as being characteristic of the deep-water fauna of the Gulf of California, one made in 995 fathoms, and the other in 1588 fathoms. We obtained in these hauls a number of Ophiomusium and Ophiocreas, some specimens of Schizaster, a new genus allied to Paleopneustes, and also the same species of Cystechinus, with a hard test, and of Phormosoma, which we had obtained before on the line from the Galapagos to Acapulco."

The Albatross reached Guaymas on the afternoon of April 23, where Agassiz left the ship and made directly for the East by rail. The collections were afterwards distributed, to be worked up, among the best specialists anywhere available, and proved far richer than one would gather from Agassiz's letters at the time. Writing of the expedition years later, he says: —

"We spent more than two months dredging and trawling with great activity, and succeeded in bringing together in that time a collection of deep-sea forms which probably has not had its equal in any other expedition. I had always hoped sometime to work with Captain Tanner, and it was natural that with our combined experience we should have been as successful as we were.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

That we had worked hard was seen at the end of our trip. At Guaymas, when I left the ship, we were neither of us in condition to do another stroke of work."

During this cruise Agassiz made a special study of vertical distribution of pelagic fauna, or the depth to which floating animals may be found beneath the surface. Some naturalists, especially the staff of the Challenger, and more recently Dr. Chun, had reached the conclusion that animal life extended to great depths in the ocean.

But the Challenger experimented on this question only during the last part of her cruise, and did not use nets that could be closed before being drawn up, so that they might collect anything on the way to the top of the water. This is the so-called differential method, which Agassiz always regarded with the greatest distrust. For example, suppose that an open net is drawn up vertically from one hundred fathoms, and a second from two hundred fathoms. By this method it is assumed that anything found in the second net that was not in the first net *must come* from between one hundred and two hundred fathoms. Dr. Chun used a net which, after being towed at a given depth, could be closed before being drawn to the surface. But most of his work was done in the Mediterranean, where the conditions are entirely different from those in the open sea, and he himself says he had difficulty in closing his net properly.

It will be remembered that in his cruises in the Blake, Agassiz had investigated this question with the Sigsbee Gravitating Trap, by means of which it was possible to filter a column of water of any desired height at any

Digitized by Google Original from UNIVERSITY OF MICHIGAN

given depth. With this instrument he had been unable to get life at one hundred and fifty fathoms. He brought on board the Albatross a net similar to that used by Dr. Chun, made for the expedition by Ballauf of Washington. This was not found to work satisfactorily and was discarded after a first attempt. But, "thanks to the ingenuity of Captain Tanner," he and Agassiz between them devised an arrangement known as the "Tanner" net. This was so weighted that it went down bottom first, thus preventing anything from getting into the net on the way. It was then towed for a time at any desired depth, and before being hauled to the surface a messenger was sent down that released two weights which tightly closed the lower part of the net, leaving the upper part open, to catch specimens on the way to the surface. On account of the simplicity of its construction and the accuracy of its action, Agassiz always considered this closing net far more reliable than any other similar contrivance.

The results of a very considerable use of the Tanner net on this expedition led him to believe that in the open ocean there is a very marked falling-off in animal life below two hundred fathoms. Later experiences, though they did not alter his general conclusions, would seem to have somewhat extended the depth to which he believed life to extend.

During his last expedition in 1907, Agassiz said, in conversation, that from the results of his own investigations he was of the opinion that in the *open ocean* there was a great intermediate belt between the pelagic fauna and the species living at or near the bottom, where there was practically no life, nothing but the falling bodies of dead animals. Where the results of other ob-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

servers had led to a different conclusion, he was inclined to attribute it to the defective working of the apparatus used. His experience in the Gulf of California, on the other hand, led him to believe that in a comparatively closed sea there may be a mixture of the pelagic species with the free swimming animals that live at or near the bottom.

This was with one exception the last of Agassiz's expeditions that was purely zoölogical. The main object of his subsequent voyages was the investigation of coral reefs and coral islands, and the questions arising from the study of their formation. During the latter part of his life he does not appear to have been greatly interested in the question of the vertical distribution of life in the ocean. On only two of his later trips did he ever use a Tanner net. On the Wild Duck in 1893, he made some casts with one off Havana, and a few in the Tongue of the Ocean in the Bahamas, which led him in no way to modify his views.

Some months after this last expedition, he says, in writing to Dr. Giesbrecht: —

"I do not wish in any way to be obstinate about my views as to the extension of pelagic life — not necessarily surface forms — to great depths. All I care to know positively is, whether at sea, far from land, the sheet of water below 250 or 300 fathoms is populated densely or so sparsely as to enable us to say that animal life practically ceases at the depths of 250 to 300 fathoms. I am not fighting for any theory, I am only stating my experience, and it is very strange that I have so invariably been unsuccessful in tracing the existence of animal life below the above-mentioned limits, while

Digitized by Google Original from UNIVERSITY OF MICHIGAN

others have always found something. I have no theory. I have merely tried to account for the differences of results obtained by Chierchia, Murray, Chun, and others by some rational explanation, and when I see one net after another abandoned or condemned in successive expeditions, I naturally condemn the results which accompanied and were deduced by them. But the writers of the results do not seem to think that the one includes the other."

In the Eastern Pacific Expedition of the Albatross, in 1904–05, Agassiz again used the Tanner net a few times, bringing up specimens (especially certain species of jelly-fish) from three hundred and four hundred fathoms. He is apparently at that time not sufficiently interested in the matter more than to mention the facts; the only comment in his notebooks of the voyage being, "nothing of any size below 350 to 400 fathoms."

The problem that Agassiz had always considered of greatest interest in connection with his deep-sea work was the comparative study of the marine fauna on the two sides of the Isthmus of Panama. When all the reports of the numerous specialists who were working on the various collections of the Blake and the Albatross Expedition of 1891 were completed, he had always hoped to summarize the results in a Panamic Report in which he expected to establish some interesting conclusions. Of this subject he says in his presidential address before the International Zoölogical Congress in Boston in 1907: —

"Much has been written on the relationship of the marine animals of the Caribbean and of the Panamic

Digitized by Google Original from UNIVERSITY OF MICHIGAN

region, but the speculations are all based upon data supplied by collections made upon the littoral regions. It was not until the collections made by the Blake on the Atlantic and Caribbean side, and by the Albatross on the Panamic side, were studied, collections extending to the deepest waters of both regions, that we were able to speculate with some degree of certainty upon the causes which led to the existence of the peculiar fauna characteristic of the deep waters of the Caribbean, a fauna more closely allied to the Panamic deep-water fauna than to that of the Atlantic, and suggesting that after the formation of the Windward Islands, which, in great part, cut off the Caribbean from the Atlantic, there must have been a free connection with the Panamic region of a depth greater than that which connected it with the Atlantic.

"It of course became necessary to carry on geological surveys to determine the age at which these connections were established, and again closed, to obtain some measure of the time elapsed necessary to differentiate the marine fauna of the two sides of the Isthmus of Panama. While the length of this period can only be vaguely inferred, it gives us at any rate the comparative measure of the changes which have taken place in these faunæ from the time when the marine fauna of the later Cretaceous was passing into the older and more recent Tertiaries, and until the existing state of things was established. The preliminary geological studies I carried on in connection with the study of the West Indian coral reefs, necessary to determine the age of the development of the larger Antilles and of the Windward Islands, have been extended for me by Hill and others, so that we now have a fair idea of the geolog-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

ical sequence of events in the growth of the Caribbean area.

"The careful, comparative study of the collections of the Blake and Albatross is now nearly complete, — a study carried out by specialists is absolutely essential, for no mere superficial sketch even by an experienced zoölogist will suffice in drawing conclusions of any value and bring out the minute, interesting, fundamental details which no general zoölogist can hope to grasp. Whatever final value the correlation of these Reports may have will be due to the assistance I have received from my collaborators in so many special fields, and my indebtedness to them I find it difficult to express."

Unfortunately at the time of his death there were a few reports of the Blake and a considerable number of the Albatross Expedition still unfinished, so the "Panamic Report" was never written.

All the unfinished reports of the specialists working on collections from any of Agassiz's expeditions will, however, eventually be published from a fund he left for this purpose.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

CHAPTER XII

CORAL REEFS

Agassiz broke the winter of 1891–92 by a visit to Japan, with his second son Maximilian. Apart from his pleasure in collecting old bronzes and porcelains, he was especially interested in a visit to a copper mine, and a trip to Bandai San. Taking a small steamer through the Inland Sea they reached Niihama on the Island of Shikoku, the site of the smelting works of the mine. Here they spent three days in the owner's house. Writing from there Agassiz says: —

"It is such a pretty place, and such beautiful things as the Manager showed us stowed away in a 'godown' as they call their warehouse. There were some lacquers and bronzes and Chinese and Japanese vases to make one green with envy, but Souvinisto Nuo, the owner of the mine, is one of the richest men in Japan. The mine has been in his family for two hundred years!! The smelting works are very well arranged, as are their stamp mills and the mine and everything is very well done. We left to go to the mine early in a drenching rain in rikishas. . . .

"Finally we reached the tunnel of the mine, which is four thousand feet above the level of the sea. The tunnel goes through the mountain and comes out the other side where the village, making up the mine, is placed in a narrow gorge of the mountain, the houses arranged in terraces, one above the other, and glad

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

enough we were to get to the Manager's house and have lunch.

"After that we went underground and examined a specimen of all their processes. They do their work very well, and I am very glad to have seen this place and to know what they propose doing. All this gives me more faith in Calumet than ever. We were great fools not to own it all, as we might have done. Such a desolate place as the mining village I never saw."

On his return to the main island, in describing his rikisha trip from the railway to Bandai San, a mountain well up in the northern part, he writes:—

"The road passes through huge tracts of mulberry orchards, just sprouting with black clusters of the tiny silkworms attached to the young leaves. We passed through a magnificent forest of the Kaika tree, a huge gnarled trunk, resembling old beeches, with a leaf like that of an elm. The villages we passed through were all farmers' villages and very poor-looking compared to those of Central Japan. . . . The mountains of the Central Range have wider and more numerous spurs, having comparatively fewer valleys and places for cultivation and this, added to the greater northern latitude, tells greatly on the general aspect of the country, which is decidedly northern and sterile. . . . At Inawashiro village, which we reached at about four in the afternoon, we found a very dilapidated inn."

This is the nearest point to Bandai San, a mountain, over 5000 feet high, which had blown up some four years previously, sending more than half its mass in a

Digitized by Google Original from UNIVERSITY OF MICHIGAN

great wave of earth and stones down the adjacent valley, covering a tract of country about fifteen by ten miles, making two large lakes by damming the river, burying many villages, and killing about five hundred people.

"After walking about a mile we came to the gravelled flow which nearly destroyed the village of Mine. This flow we followed for a mile or so, and then walked about three miles until we came to the bed of a stream entirely covered with huge boulders and sand. Both these districts were before the eruption well cultivated and filled with thriving hamlets. We walked along the river-bed for about four miles, and then crossed a low pass and a series of ravines, gradually climbing for about two hours till we reached the edge of the huge excavation made by the blowing-off of the mountain, and could see from the point we had reached the two lakes and the heaps of gravel and of boulders covering the once fertile tract, with no end of little cones formed by the minor explosions of steam which are still going on in the main cavity formed. There steam is issuing all the time and we heard many ominous noises and distant rumbling, which made us feel somewhat uncomfortable, as we were standing on the vertical edge of the bluff left standing! Max took many views which I hope will print well, and I was fortunate enough at Sendai, to find a lot of photographs taken soon after the eruption."

He reached Tacoma in June, laden with spoil; but for once his trophies were not scientific, but artistic additions to the collections of old Chinese and Japanese bronzes and porcelains that had been gradually accumulating in his Cambridge and Newport houses.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

On his way East he made his semiannual visit to Calumet, reaching Newport in time for a late summer there.

TO SIR JOHN MURRAY

CASTLE HILL, NEWPORT,
August 2, 1892.

Thanks to sundry washouts we were delayed along the line of the North Pacific and I found more to do at Calumet than I expected, so did not reach here till long after you sailed. I found your magnificent volume on the deep-sea deposits and you are to be congratulated for so fine a result. I 've only had time to turn over the leaves and look at the Plates and expect to read it carefully later. I've been here for a few days and found the Laboratory in full blast here. I hardly think I shall be able to do much work myself; the accumulations during my absence are prodigious, and it will be all I can manage to get my head above water by the fall. I am thinking of building a new seagoing launch for work in connection with the Laboratory here. I wish you could ship me one over here whole from the other side, free of duty as a piece of philosophical apparatus! My last launch was intended to be a phenomenon, and so she proved; she was so utterly unseaworthy that I was afraid to go out in her in an ordinary seaway, and she now graces the Hudson River, when the seas are not over an inch high, that she can stand.

About this time Agassiz published an extensive monograph on Calamocrinus diomedæ, a deep-sea crinoid first dredged off the Galapagos by the Albatross on her way to San Francisco in 1888, of which he had found an additional specimen in a trawl off Mariato Point in

Digitized by Google Original from UNIVERSITY OF MICHIGAN

1891. The study of this species of a new genus of stalked crinoids was of especial interest, as it bore a close relation to extinct fossil forms of past geological ages, having a striking resemblance to a large group of fossil crinoids of Mesozoic time.

For many years he had occupied his summers chiefly in the study of the development of young fishes and the life history of jelly-fish, with an occasional experiment in the protective coloration of fish and Crustacea. But after this period his research work at Newport was much curtailed by the time required to write up the reports of his previous expeditions, and by the care of the correspondence involved in the distribution of his various collections and the publication of reports of the specialists to whom they were allotted. Since there were over ninety of these gentlemen, and as Agassiz always wrote his letters with his own hand, one may gather some idea of the labor involved in keeping in touch with them.

The year 1892 marks the close of a distinct period in Agassiz's life. Until then he had devoted himself chiefly to marine zoölogy. The main scientific interest of his later life was, however, the study of coral islands and reefs, and the method of their formation. This question has a broader interest than is at first apparent, for it leads directly to a consideration of the forces which, in recent geological times, have made the surface of this planet what we find it to-day.

Many of us remember, in the physical geographies of our youth, an illustration of a coral atoll. It captivated our fancy, being so different from anything that had come within our own personal experience, for we had

Digitized by Google Original from UNIVERSITY OF MICHIGAN

not ourselves as yet associated with pirates in the South Seas. The picture, to which we loved to return from the perusal of more trying subjects, showed a low, rakish-looking schooner lying peacefully at anchor in a quiet lagoon surrounded by a circle, deceptively perfect, formed of a narrow strip of land studded with cocoanut palms, under which nestled a few native huts, whose primitive outlines appealed to our imagination. On the outside rim huge rollers, heaped up by the trade winds, beat with savage force. Those of us who, in later years, were fortunate enough to visit such regions, when a cruel civilization had swept away most of the pirates, were surprised to find that, fascinating as these atolls were, the perfectly circular land rim of our geographies was the rarest exception. Their form, often most irregular, scarcely ever even approached a true circle. The land rim, seldom continuous, and often broken by gaps of submerged reef or deeper passages, was on the lee side frequently little more than a line of breakers, with perhaps here and there a bit of half-formed land rising along its glistening curve. Sometimes the emerald green of the atoll's quiet lagoon would be bounded only by a white ribbon of sinuous breakers pounding over a convex coral reef.

It is impossible to suppose that these curious coral formations have grown up from the depths of the ocean, since twenty fathoms appears to be about the limit at which reef-building corals usually flourish abundantly. The poet naturalist Chamisso, who, from 1815 to 1818, accompanied Kotzebue on his voyage around the world, imagined that atolls grew on the summits of volcanic upheavals of the bed of the sea, which had reached sufficiently near the surface to permit the corals to obtain a foothold.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Darwin, on his return from the voyage in the Beagle, first published in 1840 his well-known theory of the formation of coral atolls, and their cousins the barrier reefs, which, at some distance from the shore, encircle an island or extend along a coast line, leaving a considerable passage between them and the land.

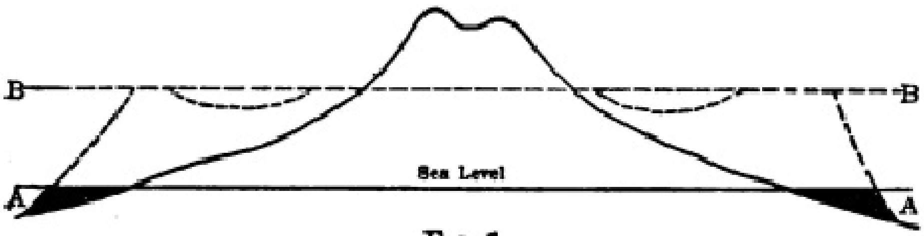


FIG. 1

Suppose Fig. 1 to represent an island along whose edges corals have begun to grow, as shown by the shaded portion *A*. Then, according to Darwin's theory, if we imagine the island gradually to subside at the same rate at which the coral grows, we would in time find a condition shown in the dotted lines, where *B B* represents the new sea level. A smaller island is now surrounded by a barrier reef, the passage between them caused by the favorable position of the outer rim for a more luxuriant growth of coral.

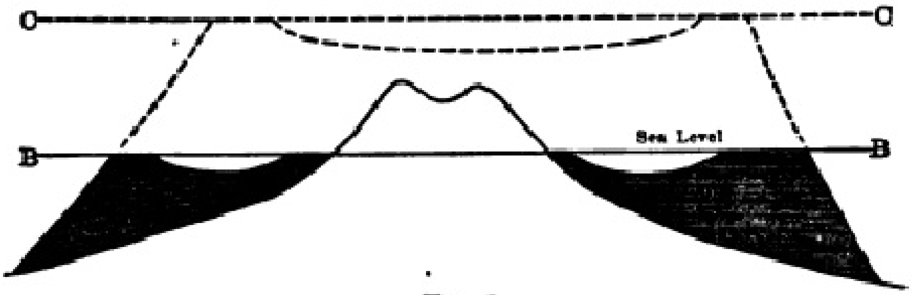


FIG. 2

Let Fig. 2 represent the second condition of the island, the shaded parts showing the coral growth. Now

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

supposing the process to continue until the island is submerged. This new condition is represented by the dotted lines. *C C* is the new sea level; nothing remains but a lagoon enclosed in a circle of coral reef, which might later be built up to form a lagoon island.

The beauty and simplicity of this theory of Darwin's appealed to the layman as well as to the man of science; it was strengthened by the investigations of Dana, published in 1849, who as naturalist accompanied Captain Wilkes on his memorable voyage from 1838 to 1842. For many years it remained unquestioned as the true explanation of the causes that had led to the creation of these curious formations. But this theory does not rest on the patient investigations that characterize Darwin's other work; he himself says in his autobiography [1] that it was formed before he even saw a coral reef. Keeling was the only atoll on which he ever landed, and his investigation of barrier reefs was limited to Mauritius and Tahiti. Dana's observations, although more extensive, appear to have been much curtailed by Wilkes's fear that his distinguished companion would be eaten by savages.

Both Darwin and Dana, it may be noted, have assumed a possibility as a fact, and the theory once given, have attempted to prove the subsidence, instead of bringing the subsidence of coral reefs in support of the theory. Indeed, the advocates of Darwin's view have assumed a subsidence from the existence of atolls in regions where there are innumerable proofs of elevation.

Gradually, a few men of science began to suspect that the true explanation of the formation of coral reefs might not be so simple. As early as the middle of the

[1] *Life and Letters*, vol. I, p. 58.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

last century both Louis Agassiz and Le Conte had felt the difficulty of applying Darwin's theory of subsidence to the conditions existing along the Straits of Florida. Semper, who in 1863 visited the Pelew Islands, was satisfied that the theory did not offer an explanation of the formation of the coral reefs of that region; and Murray had returned from the voyage of the Challenger convinced of the fallacy of the conception. Mr. Henry O. Forbes, who visited Keeling Atoll some forty years after Darwin, could not satisfy himself that there was any proof of subsidence there, or that the causes cited by the opponents of Darwin's theory were not sufficient to account for all the phenomena he observed. When Agassiz was in Edinburgh, helping to distribute the collections of the Challenger, he and Murray had many talks on the subject, and Agassiz then expressed his hope of investigating the question for himself.

During his cruise on the Blake, Agassiz satisfied himself that Darwin's theory could not account either for the formation of the Florida Reefs, or the Alacran Reef, an atoll-shaped coral growth to the north of Yucatan. For it seemed evident to him that subsidence could not offer a correct explanation for events that had taken place in regions of elevation, or districts that had long remained stationary. He reached the conclusion that the coral reefs of these localities had begun their growths on banks which had been built up by various agencies until they had reached a point where the depth was suitable for the growth of corals, and that in this region the coral reefs were a comparatively thin crust resting on such foundations. The accuracy of this view for that district is believed to have now been settled by the examinations of the borings of artesian wells, which show

Digitized by Google Original from UNIVERSITY OF MICHIGAN

the thinness of the coral formations. Writing to Huxley at a somewhat later date, Agassiz says: —

"A short time ago I received from an artesian well at Key West samples of rock one thousand feet from the surface, entirely made up of Foraminifera, débris of Mollusks, Echinoderms, and Crustacea, rock very similar to that now forming on the Pourtalès plateau off Key West in three hundred fathoms, and totally different from coral reef rock, a strong probability that the underlying rocks of the Florida plateau were built up as I suggested from my dredgings of rock similar to that of the Pourtalès plateau up to the depth at which coral reefs could begin to grow, when they took the prominent part."

The newer theories of the formation of coral reefs and coral islands are chiefly associated with the names of Agassiz and Murray, who were in the main in accord in their ideas on the subject, though in some cases they apparently differed as to the amount of work done by modern corals, and seem to have placed somewhat different values on the relative efficiency of the action of erosion, solution, and the scouring force of the ocean in the formation of atolls and barrier reefs. Murray laid much importance on the effects of solution in creating lagoons and the passages between barrier reefs and the land, while we shall see in Agassiz's subsequent expeditions the manner in which he believed them to have been produced. In a letter to Huxley he says on this point: "I do not believe that solution as such has produced the effects Murray ascribes to it. It has been a factor, but a more limited one than he assumes."

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Stated roughly, Agassiz believed that corals, especially modern corals, have played a far less important rôle in the formation of atolls and barrier reefs than Darwin's theory would imply. The corals merely take up their work after the banks and shoals prepared for them have reached a suitable depth, or height, for their growth. These shallows owe their existence to various causes, which differ in different localities; they may be due either to accumulations of silt, deposits of the shells of marine animals, the erosion of volcanic islands, or æolian limestone hills, or other non-coralline limestones, and in some cases they appear to have been formed from what is apparently Tertiary coral rock. It is an essential part of Agassiz's theory, as will be explained in a later chapter, that he considered the origin of these Tertiary coral formations an entirely separate question from the method of formation of modern coral growths.

It will readily be seen that Darwin's theory demands a very considerable thickness of coral formation. Thus in any locality where the existence of only a comparatively thin layer of coral can be proved, it may be assumed that Darwin's theory does not hold good. On the other hand, a thick mass of coral rock would not necessarily indicate subsidence; for, as both Murray and Agassiz have shown, such a formation might have originated from the growth of a coral reef pushing out to sea on its own talus the débris of the reef, which, broken off by the waves, had rolled down and built up its outer slope. Furthermore, where a modern reef had obtained a foothold on an eroded platform of older limestone containing corals, it would often be exceedingly difficult by boring to detect from the core the difference between them.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Although most naturalists who, since Dana's day, have examined coral reefs in the field have found difficulty in reconciling what they saw with Darwin's theory of subsidence, still the idea proved singularly tenacious of life. This was probably in part due to the authority that would naturally be given to any statement of Darwin, and perhaps also to a failure fully to recognize that the question was in no way connected with the theory of evolution.

It is worth emphasizing that the strongest opponents of the new theories were men who had never seen a coral reef, and may possibly have been in somewhat the same attitude of mind as a frank layman of Agassiz's acquaintance, who confessed that, having acquired Darwin's theory in his youth at the cost of much pain and labor, he could not possibly assimilate another.

Had Darwin lived to see the mass of evidence controverting his theory which has been collected since his day, it does not seem improbable that he would greatly have modified his views. Darwin used good-naturedly to assure the elder Agassiz that if he lived long enough he would be converted to his theories of evolution. Might not Alexander have said the same to Darwin on the subject of coral islands?

Wishing to continue his study of coral reefs, begun on the Blake, Agassiz spent several weeks at the Tortugas in 1881, where he had quarters in Fort Jefferson. He selected this spot because he then considered the coral reefs of the Tortugas to offer a sort of epitome of the probable method of the formation of the southern part of the Peninsula of Florida.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

TO DARWIN

TORTUGAS, April 16, 1881.

It is very natural you should be in my mind, as I am in the midst of corals. I came down here about six weeks ago to study the surface fauna of the Gulf Stream. The Coast Survey placed a small launch at my disposal to go out and scour the surface when the weather is favorable. Unfortunately thus far I have had little chance to accomplish what I started to do, as I find is nearly always the case on the seashore — you never can do what you wish, but have to be satisfied with what turns up. Thus far I have only found the more common things with which I was familiar from my former Blake experience and from meeting them late in the fall at Newport.

I took advantage of bad weather to finish up a lot of drawings and notes on Velella and Porpita, and have some interesting things about the post-embryonic stages of both, which I hope to publish next summer if I get time to finish the drawings. The greater part of my time I spend in running round inside the reef in the launch and getting at the distribution of the different genera of corals. The number of species here is not great, so it makes their mapping out a simple matter. The Tortugas being the very last of the Florida reefs I find much that has not been noticed before and helps to explain, somewhat differently from what was done by Father, the formation of the reefs. On my way here I went across the northern base of the Peninsula of Florida — from Jacksonville to Cedar Keys, and found halfway across a series of hammocks and old coral reefs, such as are found in the Everglades at the southern extremity. In

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

tracing the growth of the reefs and the formation of the Peninsula, I have come across no signs of any elevation. Everything, on the contrary, tends to show that the immense plateau which forms the base upon which the Peninsula of Florida is formed, was built up by the débris of animal remains,—Mollusks, Corals, Echinoderms, etc. (after it had originally reached a certain depth in the ocean), until it reached the proper height for corals to flourish. This here is not much deeper than seven to eight fathoms; generally six fathoms marks the limit. To the westward of this group of reefs is a coral reef starting on a bank at a depth of seven fathoms.

I expect to publish a small map of the distribution of the corals of the Tortugas as soon as I return home, in my report of work (not done) to the Superintendent of the Coast Survey. I shall, however, have first to finish reading the proofs of the Challenger Echini, the last pages of which I expect to find awaiting my return home, and I trust you will see that Memoir out during the summer.

To this Darwin replied in a letter characteristically full of courtesy and open-mindedness, qualities not always conspicuous in scientific discussions. It has already been published in "More Letters of Charles Darwin," but a few passages may not be out of place here:—

"You will have seen Mr. Murray's views on the formation of atolls and barrier reefs. Before publishing my book I thought long over the same view, but only as far as ordinary marine organisms are concerned, for at that time little was known of the multitude of min-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

ute oceanic organisms. I rejected this view as from the few dredgings made in the Beagle in the South Temperate regions, I concluded that shells, the smaller corals, etc., etc., decayed and were dissolved, when not protected by the deposition of sediment; and sediment could not accumulate in the open ocean. . . . I have expressly said that a bank at the proper depth would give rise to an atoll, which could not be distinguished from one formed during subsidence. . . . Lastly, I cannot understand Mr. Murray, who admits that small calcareous organisms are dissolved by the carbonic acid in the water at great depths, and that coral reefs, etc., etc., are likewise dissolved near the surface, but that this does not occur at intermediate depths, where he believes that the minute oceanic calcareous organisms accumulate until the bank reaches within the reef-building depth. But I suppose that I must have misunderstood him. Pray forgive me for troubling you at such length, but it has occurred to me that you might be disposed to give, after your wide experience, your judgment. If I am wrong, the sooner I am knocked on the head and annihilated, so much the better. It still seems to me a marvelous thing that there should not have been much and long-continued subsidence in the beds of the great oceans."

Murray at the time does not appear to have made his point clear to either Darwin or Agassiz that the formation of a bank by the deposit of the shells of small pelagic animals falling to the bottom, was merely a question of their accumulating faster than they dissolved. Before reaching great depths, the shells would, in falling slowly through the water, be dissolved faster

Digitized by Google Original from UNIVERSITY OF MICHIGAN

than they accumulated on the bottom. This would also be the case in shallow water, where a thin layer of pelagic life would not furnish so many shells. At intermediate depths, on the other hand, the shells, having less distance to fall, would be less dissolved, and would accumulate.

TO DARWIN

CAMBRIDGE, May 19, 1881.

I find on my return from the Tortugas your most welcome letter of May 5. I am now at work on the Report of the Coral Reefs of the Tortugas, and hope during the course of the summer to be able to send it to you. As you well say, the fact that the Peninsula of Florida should have remained at the same level for so long a time is most surprising. This I consider to be in part due to the original orographic conditions of the Gulf of Mexico, as we have not only the Florida Peninsula but other equally important banks: Yucatan, Bahamas, and San Pedro Banks, all of which are characterized by a general dead level which they have evidently kept for an immense period of time. Yet on the other side of the Straits of Florida and all along the line of the larger Antilles, as far as Barbados, and along the northern of the Windward Islands, we have the *most distinct proof of elevation*. . . .

I should feel at present inclined to assign to the action of large marine animals (such as Gorgoniæ, Starfishes, Mollusks, Echinoderms, Deep-sea Corals, Crustacea, etc.) a more important part in building up a plateau, up to the height at which corals can thrive, than to the pelagic fauna which I would look upon more as the cementing medium, but which, however, in some localities, such as

Digitized by Google Original from UNIVERSITY OF MICHIGAN

are in the track of great oceanic currents, as the San Pedro, Yucatan and Florida and Bahama Banks, do yet form an important bulk in the mass of the débris added to the original bank, the level of which was due to the folding of the crust in much earlier periods, at a time when the principal orographic features were laid down. My experience has been that shells, etc., in these plateaus which are in the track of currents, are fairly well preserved after death, although covered with mud (made up mainly of the coral ooze and of Globigerina ooze) which cemented them to the older layer of dead shells, etc., below, and formed the base upon which the present living forms were thriving. Your objection that there is not great probability of finding in the Pacific as many banks as there are atolls is certainly a very strong one and one which seems to me can only be met by showing in subsequent surveys that these atolls are themselves only slightly raised patches upon large banks, the orography of which we do not as yet know. This is a problem in hydrography of the Pacific which I have had in view for a long time and hope to solve one of these days.

With reference to the chemistry of the reefs and the action of all this large amount of carbonate of lime held in suspense in the water, I must acknowledge I know nothing, and I do not see the why of the action of carbonic acid as a solvent at one depth and not at another —if not in exact proportions to the pressure. This part of Murray's argument seems to me untenable, if I understand him correctly, and we seem to have viewed his explanation alike. There is constant talk of making borings at St. Augustine for sinking artesian wells, and whenever they start I shall be sure to keep close watch of their proceedings, which ought to settle a good

Digitized by Google Original from UNIVERSITY OF MICHIGAN

many doubtful points as to the structure of the Florida Peninsula.

I am much pleased at what you say of my address; the part you refer to is just the one which seemed to me to throw some light on the infinite lines of affinities, which close study reveals, among otherwise distinctly related groups, and it was the very difficulty of expressing this affinity by any of our present methods of notation which made me almost despair of doing more than to follow a single character in its endless modifications in time and space.

During a visit to the Hawaiian Islands in 1885, his examination of the coral reefs convinced Agassiz that this was another region not explained by Darwin's theory. The only indications of subsidence he found were slight and local; and he explains the great width of some of the reefs by the growth of the corals seaward on their own talus, a process which he points out might in time produce a very great thickness of coral rock. In some places, as in Kaneohe Bay, he was able to determine that the modern reef forms only a thin crust over the underlying volcanic rock. He believed the barrier reef of Kaneohe Bay to rest upon a platform formed by the washing down and disintegration of a lava crest to a depth at which corals could flourish — the first instance where such a formation had been noted. He was also able to show that the more elevated limestone rocks were æolian, that is, they had been formed of the sand from coral beaches blown into dunes by the action of the wind, and cemented by rain-water into rock.

The supporters of Darwin's theory answered Agassiz's report on the coral reefs of the Hawaiian Islands by

Digitized by Google Original from UNIVERSITY OF MICHIGAN

replying that, granted the correctness of Agassiz's views, the district was simply another exceptional area. This criticism he was destined to meet with such tantalizing frequency in after years, that his subsequent expeditions might almost be called a search for a typical coral region.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

CHAPTER XIII

1893–1894

THE BAHAMAS AND BERMUDAS

THE exploration in 1893 of the Bahamas and the Cuban coast was the first of Agassiz's expeditions having for its main object the study of coral reefs. For this voyage Mr. J. M. Forbes lent him the auxiliary steam yacht Wild Duck, and through the kindness of the State Department, the Spanish authorities granted the yacht free access to all Cuban ports. In order further to facilitate the expedition, the Superintendent of the Coast Survey appointed Agassiz an "Acting Assistant," remarking in his letter that there was but one other assistant of this "grade and rank," a Jesuit Father in Alaska, so that it was evident that the distribution of such favors was not influenced by politics or religion.

The Wild Duck was a light-draught, small displacement schooner, about one hundred and twenty-five feet on the water line, whose engine enabled her to steam about ten knots an hour. To give an added interest to the expedition, Agassiz equipped her for pelagic work. The Fish Commission lent a Tanner sounding machine, and the Coast Survey some deep-sea thermometers. Six hundred fathoms of wire rope were put on board, together with several Tanner closing nets, dredges, trawls, and tow nets. By increasing the diameter of the steam capstan with lagging, the wire rope could be hauled in at the rate of one hundred fathoms in eight minutes.

Digitized by Google | Original from UNIVERSITY OF MICHIGAN

It was found, however, that in a boat of this type and size it was impossible to handle the apparatus in the long roll of the trades, without the greatest danger of injury to it, and less pelagic work was accomplished than was at first intended.

Agassiz joined the yacht at Jacksonville; he had with him, as assistants, his son Maximilian, the photographer of the trip; Dr. A. G. Mayer, a former student of the Newport Laboratory; and Mr. J. H. Emerton, the zoölogical artist. Leaving Jacksonville on January 8, the party sailed directly for Nassau, which they made their headquarters. Here they were fortunate in securing the best pilot of those regions, a darkey who had been in the service of the Government for twenty years and was supposed to know everything that a black man can. Profiting by the light draught of the Wild Duck, and the exceptional skill of his pilot, Agassiz was enabled to cross the banks in all directions and penetrate into regions otherwise inaccessible. Many of these trips on the banks tested the pilot's ability to the utmost; for with marvelous skill he worked the yacht across the sandbars over one spit and then another, using only the eye or the bearing of some distant little cay. On more than one occasion they anchored in such unusual places for a vessel of their size, that the spongers swooped down on them under the impression that they had gone aground — and were much disappointed at being defrauded of a first-class wrecking party. "Such a set of darkey cut-throats I should not care to have landed on my deck if my vessel was ashore — they looked as if they would leave you but little show."

The first cruise[1] embraced the outer chain of islands,

[1] See Chart 1.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

from Eleuthera as far east as Turk's Island. Touching at Watling's Island, the first landfall of Columbus, Agassiz compared the shores of the island with the descriptions given by Columbus, and satisfied himself that the spot selected by Sir Henry Blake was the place where Columbus first landed in the New World. This bit of the shore, known as Columbus Bight, is situated well down on the east coast of the island.

From Turk's Island the yacht headed for Cape Maysi, and then, skirting along close to the southern shore of Cuba, put into Santiago for coal and supplies.

SANTIAGO DE CUBA,
January 25, 1893.

"We had a most interesting trip yesterday to the iron mines near here, at a place called Juragua. The most important mines belong to the Pennsylvania Steel Company and to the Bethlehem Iron Company; they own a large territory and run their works at Steelton, Sparrow Point, and Bethlehem entirely on the product shipped from here, which in all amounts to about 500,000 tons a year. The General Manager is a German, a Pennsylvania Dutchman, and the bulk of the officials are of the same mixed nationality. We left here early in the morning at six, just at daylight, — that 's the time all trains start, and went up in what they call the Director's Car, a small locomotive on four wheels with seats for six. All the way to the mine, about sixteen miles by rail, the geology was most interesting, and I managed to do a good bit of work of seeing, by stopping off and on. For nearly eight miles the railroad runs on one of the elevated coral reefs, about twenty feet above the level of the sea, and I managed at a

Digitized by Google Original from UNIVERSITY OF MICHIGAN

place called L——, where the railroad strikes off inland, to make an excellent collection of corals from the terrace, while the locomotive was waiting for its right of way. The officials of the mine were quite as interested in that part of my visit as in anything else, and we got crowbars, chisels, and all kinds of tools to cut out some good-sized heads, which are now safely on board. There are three parallel elevated terraces here off this part of the coast, and from the highest, one hundred and sixty feet above the level of the sea, I got some coral heads also. If I have as good luck at Baracoa on the elevated reefs there, and along the north coast, I shall have no cause to complain. A day like yesterday goes far to explain a lot of things.

I only wish we could stay out longer and not be obliged to go in for coal and ice so often and waste so much time in port. But I am thankful for what I have; it means simply a little less work and a good deal more expense than if I had such a boat as the Albatross, when you can stay out thirty days, and then spend no more time fitting out again than we do. The Messrs. Brooks & Company, to whom I gave my letter of credit, were most polite to us, and all the people here in charge of anything have simply been devotion itself. But everything in Spanish ports costs about twice as much as in Nassau, and this is the last time I shall fit out in a Spanish port, I hope. But what I have seen has fully paid so far. I fancy this trip will cure me of any other similar yachting cruise. It looks to me as if it were a little too much for a private party."

Again skirting the coast to Cape Maysi, and later, on a trip along the north shore of Cuba, Agassiz was

Digitized by Google Original from UNIVERSITY OF MICHIGAN

able to get an excellent impression of the elevated terraces that form such an important feature of this part of the coast of Cuba. On the way north from the east end of Cuba, after touching at Inagua, the yacht anchored in Hogsty Reef. This is a horseshoe-shaped line of breakers with an opening at the western end into an enclosed lagoon, and forms an atoll about five miles by three, which, with the exception of two little cays, one on each side of the entrance, composed of broken fragments of coral, has not yet had time to make any land. The line of coral reef over which the sea breaks, except in one or two exposed spots, has at least a foot to a foot and a half of water over it even at low tide, but as the reef was some one thousand yards wide, the interior of the lagoon was quite calm, though encircled by bands of white combers piled up by the heavy roll of the trade winds pounding on the flats.

Agassiz, now for the first time anchored in a lagoon, was much impressed by the novelty and strangeness of riding quietly in three fathoms of water, surrounded by lines of huge breakers, with nine hundred fathoms a short distance beyond, and forty-five miles to the nearest land.

Here he passed three days, surveying, sounding, and investigating; and reached the conclusion that the atoll was probably formed by a growth of coral on a bank previously formed by the wearing away of a series of small æolian hills. The existence of the lagoon he attributed to the mechanical action of the surf rushing over the reef. For he thought the mass of water poured over the rim would be a sufficient scouring force in time to hollow out the lagoon within, where, moreover, the conditions were less favorable to a luxuriant growth of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

coral. This view was strengthened by his examination, the following year, of the so-called small Serpulæ atolls in the Bermudas, which are undoubtedly made in this way. But his judgment in the matter was still in the balance, for he asks, "How deep can it act on a large scale so as to produce an effective result?"

The next anchorage was on Crooked Island Bank, where the pilot managed to find two and a half fathoms, at a spot marked one fathom on the chart. Leaving Crooked Island the yacht visited Long Island and Great Exuma, steamed along the line of cays that skirt Exuma Sound, and entering the bank at Conch Cut crossed to the Tongue of the Ocean, and so back to Nassau.

On his second cruise he explored the bank as far as Great Ragged Island, the point from which Columbus sailed for Cuba. From there Agassiz struck across to Baracoa on the northeastern end of Cuba, and cruised along the north shore as far as Havana, stopping at numerous ports and islands to examine the geology of the coast. He was much interested in the flask-shaped harbors, so characteristic of the Cuban shores, and came to the conclusion that they were due to the gradual cutting away of the drainage area, of which they are the sinks, during the elevation of the coast. Everywhere he was received with the greatest courtesy and consideration, the captains of all the ports having been instructed to allow him to go in and out as he pleased, without the usual formalities.

The following letter was written at various times after leaving Havana, as the ship zigzagged from island to island back to Nassau:—

Digitized by Google Original from UNIVERSITY OF MICHIGAN

On Board the Wild Duck,
Feb. 27, et seq., 1893.

"We left Havana the 24th with a splendid day, which enabled me to do a lot of deep-sea towing just outside of Morro Castle in deep water, and most successful it was. We had a splendid run to Salt Key Bank, visited Cay Sal, double headed Shot Cay, where there is a fine light on the English side of the Gulf Stream, and where we have found a nice old Scotchman and his wife who had not seen a soul for three months! They live on a bare rock, but the house is quite comfortable, and what with goats and hens and fishing they manage to get a little variety in their food. We left them some sugar, of which they were out, to their great delight. We then went to the southern islands of the Auguila Bank, and from there crossed to the Great Bahama Bank again, and to-day we have been exploring two points of the Island which have been most interesting and instructive and have given me just the clue I wanted to settle the cause of the present configuration of the Bahamas, so that the cruise has been eminently satisfactory.

". . . Since we left Andros we have had magnificent weather; from Billy Island at the north end of the Island, we crossed the bank to Orange Cay, and had as smooth a day as we well could have and just enough breeze to keep us cool. From Orange Cay we ran up to Gun Cay, where we anchored for the night and examined the Island the next A.M. before starting. We then steamed along a lot of islands which could be as well examined from the deck as we passed, and landed next at Great Isaac, one of the most interesting islands of the group. It seemed to have a little of everything which I wanted to see. Next came a lot of diminutive islets,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

no larger than a man's head, and then we had a run of forty miles across the bank again to reach Great Harbor near Stirrup Cay, where we anchored last night close to a lighthouse, which enabled us to make the port; but anyway the moonlight was so bright that we could have gone in anywhere, and the evening sail was perfect.

From Stirrup Cay, where we were anchored in the prettiest little bay you can imagine, we steamed close along the Berry Islands and crossed over to Andros to Mastic Point where young Chamberlain[1] has a sisal plantation. We fired a gun as we anchored off one of the most beautiful coral reefs I have ever seen, and rowed inside the surf to his wharf, close to which he has built a most comfortable and roomy house of the Nassau pattern. He has two thousand acres in cultivation, but I fancy leads an absolutely isolated life. He has one English assistant — everybody else black as the ace of spades.

"We arrived at Nassau late last night, having suddenly given up the last part of our cruise, as the weather looked threatening, and the pilot did not think it prudent to anchor off Andros in case a norther came up, as all the appearances indicated."

The rest of the voyage Agassiz devoted to a trip among the islands to the north of Nassau, and to numerous short expeditions from Nassau as a base. In his three months' wanderings in the Bahamas he travelled nearly four thousand five hundred miles in all possible directions, and visited most of the islands. Late in March he left the yacht in Florida and reached Cambridge early in April.

[1] Son of the English statesman.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

What he saw of the elevated terraces of eastern Cuba convinced him that his first examination of this coast, made many years before, had led him to misinterpret their true nature. In common with other naturalists, he had supposed that all these elevated limestones were coral reef rock, representing coral reefs perhaps twelve to fifteen hundred feet thick. He was now able to satisfy himself that the first terrace was a true coral reef which had been elevated to a height of thirty feet or less. The limestones of the second, third, and higher terraces, on the other hand, he considered were of older age and different origin than those of the first elevated reef which flanks the shore. Although he found an occasional mass of a species of reef-building coral in the older limestone, this did not lead him to believe that these rocks belong to the group of reef-building corals, any more than he would have spoken of a few isolated heads of reef-building species found along any shore line as constituting a coral reef. Moreover, since he found the older limestone underlying the coral reef rock of the first terrace, he was inclined to believe that the presence of the fossil corals in the higher terraces might be explained as the remains of a similar veneer of about the same thickness as the first terrace, say twenty-five to thirty feet, which had covered the higher terraces at the time of their elevation.

Recognizing the necessity of a more careful survey by a younger man, Agassiz afterwards sent Professor Robert T. Hill to investigate this question. Hill was able to establish the Tertiary origin of the older limestones of which he writes: "In fact I do not believe that any of the Tertiary limestones are of reef rock origin, but they are mostly organic and chemically

Digitized by Google Original from UNIVERSITY OF MICHIGAN

derived marine sediments, mixed with the calcareous débris of the life of the ocean's slopes." Professor Hill was also able to trace a post-Tertiary folding in the older limestones, and so establish an *unconformity between the older limestone and the modern reef rock*, which separated them into two distinct systems. From all of which we seem led to the interesting conclusion that the reef-building corals have played a far smaller part in the formation of the terraces of Cuba than was previously supposed.

Agassiz found that the Bahamas, as far as Turk's Island, were of æolian origin. They were formed at a time when the banks must have been one huge irregularly shaped mass of lowland. From the sand of its great sea beaches, successive ranges of dunes were blown up, such as are still found at New Providence, which the action of the rain and spray has hardened into æolian rock.

He assumed that the "ocean holes" which he surveyed on the bank were made above water, and are similar to the holes found in the æolian rocks on land, and concluded that the Bahamas have subsided about three hundred feet since the formation of the æolian land. During this subsidence the wasting forces of the sea and air have little by little eaten away the land, leaving only here and there narrow strips in the shape of the present islands. The modern coral reefs form but a very insignificant part in the topography of the islands and have had nothing to do with the building up of the islands beyond filling here and there a bight or a cove with more modern reef rock, and they form but a comparatively thin coating on the æolian rock.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

As a result of this investigation of the Bahamas, Agassiz believed them to embrace another region of coral reefs whose formation could not be explained by Darwin's theory.

TO SIR JOHN MURRAY

CAMBRIDGE, April 13, 1893.

A few days ago I got back from my trip to the Bahamas. I was quite successful as far as the general reconnaissance of the islands is concerned, but I have learned little more regarding coral reefs and am as far in the dark on the subject of the underlying rocks plateau as I was before I left. It looks to me now as if nothing but a series of systematic diamond drill explorations would settle the disputed points. And I should greatly like next year, if it does not cost too much, to do a little drilling — one hole in Florida, which has been stationary — one hole in the Bahamas, where there has been a slight subsidence — and one hole along the Cuban coast somewhere right through the elevated coral reef terraces, unless I can find a better place in Jamaica, which I do not know.

By the way, I am satisfied that the same causes which have given the Bahamas their present physiognomy have been the cause of the Bermudas assuming their present outline. The coral reefs have of late (geologically late) had absolutely nothing to do with this, and the talk about the present reefs of the Bermudas and Bahamas having been instrumental, owing to subsidence, in giving those islands their present shape, is all moonshine. There is nothing to be seen at the Bermudas or Bahamas which gives us any clue of how these islands were formed by the reefs — we are as

Digitized by Google Original from UNIVERSITY OF MICHIGAN

much in the dark in regard to their early origin as ever. The enclosed will give you a little sketch of what I have seen. I had a beastly time, thanks to unusually heavy trades which made pelagic work very difficult, so I did but little. It was aggravating, as I hoped to do lots, having two artists on board who simply ate their heads off! Has not the British Association for the Advancement of Science appointed a committee to act on the boring of coral reefs? If so, who is the active man and what do they propose doing?

TO HUXLEY

CAMBRIDGE, Dec. 24, 1893.

The old year is so far gone that I must not forget to send you my best wishes for the new. I am trying the experiment of staying at home this winter and putting my affairs to rights, which have got badly mixed from my frequent and prolonged absences. I hope the doctor will let me remain here, but I fear some fine morning he will pounce upon me and ship me South. I hoped this winter to continue my explorations of the coral reefs of the West Indies, and my experiments on the bathymetrical distribution of the surface fauna. I don't believe a word of all the pretty theories my German friends have. It's very strange how they always manage to find something at any depth they wish. My machinery never works that way, and as I have tried a hundred times to their once, I feel naturally very skeptical. But my scheme could not be managed this year, — no yacht to be had.

My Bahamas notes are now well written out, and I hope to get out this first contribution to the history of the West Indian coral reefs during the summer.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

It is becoming very evident that the whole theory is pretty complicated and coral reefs have done far less work than they have been credited with, at least in the Bahamas.

My Reports on the Albatross Expedition of 1891 are making fine progress and I hope to get out this year ('94) the Holothurians and the Crustaceans. Both these Memoirs will have colored Plates, giving a good idea of the looks of many of these deep-sea beasts. Dr. Pelsener wrote me the other day to ask for the Blake Spirula which you sent back, and for the life of me it cannot be found, it has been so admirably put away! — by some zealous person too orderly inclined.

My youngest son has managed to become engaged to a very charming girl from Philadelphia. I am somewhat taken aback; not having had any experience with daughters I hardly know how to behave. So far it's a very delightful experience.

After his visit to the Bahamas it was natural that Agassiz should turn his attention to the Bermudas; writing from Cambridge early in 1894, he says to Murray of this proposed visit: "So far I have managed to stay here without any great detriment and am getting fat on it. But the doctor does not think it very safe for me to stay much longer, and by the middle of next month I'll make a visit to the Bermudas."

He spent nearly a month there, examining the structure of the group and concluded that the Bermudas offered an epitome, as it were, of the physical changes undergone by the Bahamas. The following letter gives an excellent idea of his views on the formation of this region: —

Digitized by Google Original from UNIVERSITY OF MICHIGAN

TO SIR JOHN MURRAY

HAMILTON, BERMUDAS,
March 12, 1894.

I've been here nearly a couple of weeks examining the islands and running out to the reefs whenever the weather will allow. I've had so far not many pleasant days. March is nearly as windy here as at home, but of course far preferable. There is an excellent tug of which I have the refusal every morning; this has enabled me to see a good deal in a very short time. I've made four sections across the reefs and am quite satisfied that corals here have had still less to do with the present configuration of the islands than at the Bahamas. The problem here is practically the same, but the corals are so unimportant an element in the so-called reef as to form practically the thinnest kind of veneer over the ledges of æolian rocks which form the so-called Northern, Western, and Eastern Reefs.

The Northern Rock, Mills Breaker, and a lot of rocks which are awash, are all of æolian formation, the remnants of the former Proto Bermudas land when it occupied the greater part of the bank as an oval highland full of æolian hills which have been eroded and eaten away, and left the ledge on which the thin veneer of corals, Alcyonoid, and Millepore have built. All the patches between the outer reef and the islands are similarly fragments of the former land coming within the five fathom line quite close to the *L W M*, many of them, and veneered in the same way. That these patches are nothing but sunken islets and ledges can be plainly seen anywhere along the north and south shores, where they are still actively forming, especially on the south shore,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

where the so-called reef is nothing but a series of islets and ledges overgrown by Serpulæ and Algæ, which, in the long stretch from Tinker's Farm [?] to the Gibb's Hill Bay on the south shore, form no end of atolls, barrier reefs, and crescent-shaped reefs. But the rising rim is *not* formed by the growth of the Serpulæ. The outer edge is merely protected by Serpulæ and Algæ, and the surf breaking over that protected edge digs out a deep hole and thus are formed potholes (atolls) or crescent-shaped reefs, if there is an outlet broken out, or a barrier reef if it is a shore ledge which is acted upon by the surf.

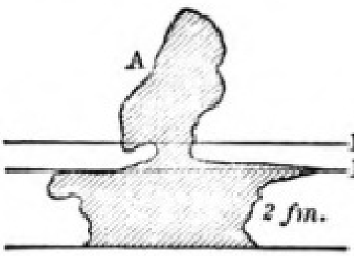


Fig. 1

I had before seeing these little atolls always supposed the vertical walls were built up by the Serpulæ, but it 's no such thing — four to six inches is the highest Serpulæ thickness I 've found, and everywhere where I have looked into the rim of an atoll, etc., it has always been made up of *æolian rocks!* — the walls left by the eating and scouring of the surf on blocks of æolian rocks, of all shapes, after they have been reduced to the line of the sea. This will show you my idea: —

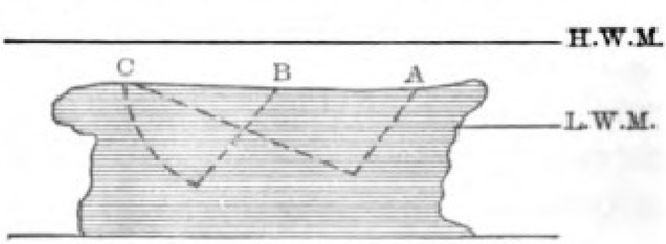


Fig. 2

When the rock *A* [Fig. 1] is cut if at *H W M*, it leaves a flat ledge at *L W M;* the block *A* falls to one side and is, according to its size and thickness, then acted upon by the surf and breakers, and disintegrated accord-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

ing to the angle at which the strata meet the sea, and may in its turn form one of the Serpulæ atolls or knobs. The ledge which is left [Fig. 2] below *L W M*, composed

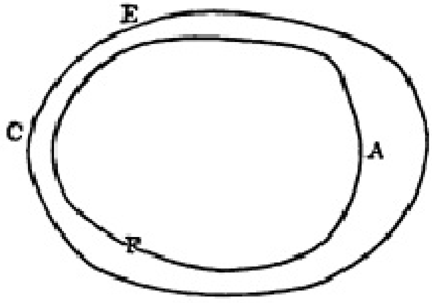


Fig. 3

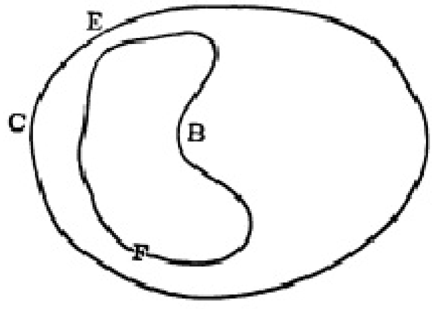


Fig. 4

of æolian strata which have been cemented together by the solving action of the sea, is coated by a hard crust. Algæ and Serpulæ and all the beasts of a Serpula atoll are already growing upon the ledge. But as soon as the water instead of playing round the ledge begins to break upon it, it will soon eat away the softer part of the interior, or where not so well protected and, according to the slope of the strata of the ledge, will form an atoll if horizontal, if a little inclined a crescent-shaped reef, and if it is a thin ledge a barrier reef, as per sketches.

From horizontal strata the Algæ and Serpulæ may cover the bottom slope *A C* or *B C* [Figs. 3 and 4], but if the surf is too great the sides *E F* are broken off, and thus are formed isolated broken walls of all shapes and outlines. [Fig. 5.]

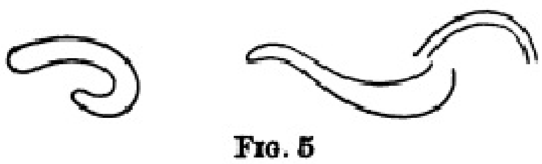


Fig. 5

If the strata are dipping and in the same block, we may have, as in all æolian rocks, strata dipping at all angles, which will account for the diversified shapes.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

The mushroom rock is eaten away, or rather pounded away, along the line *A C* [Fig. 6], leaving a crescent-shaped wall at the level *A*, and the water all falls out at *C* [Fig. 7].

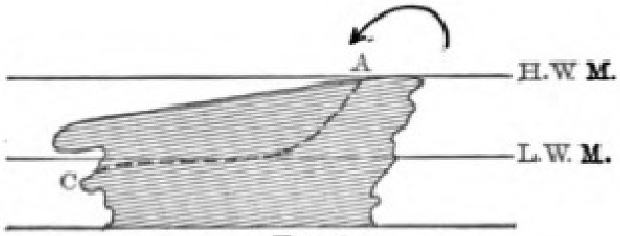


Fig. 6

At the foot of a vertical cliff a ledge is frequently formed [Fig. 8], and the surf during low tide pounds over *A* and cuts away all the dotted part *A C*, forming a regular barrier reef at the foot of the cliff, with as much as eight feet in one case, a regular slope from *A* to *C*. If this slope is protected by Algæ or corallines, it is not eaten away, otherwise it may make a pothole inside the wall. Then vertical walls are of all shapes, winding around and twisting, forming all kinds of reëntering curves [Fig. 10].

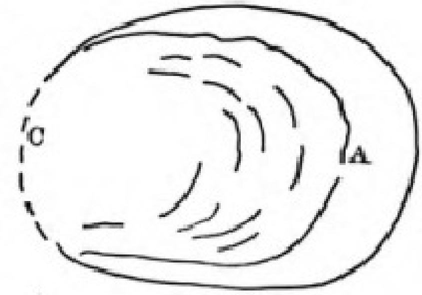


Fig. 7

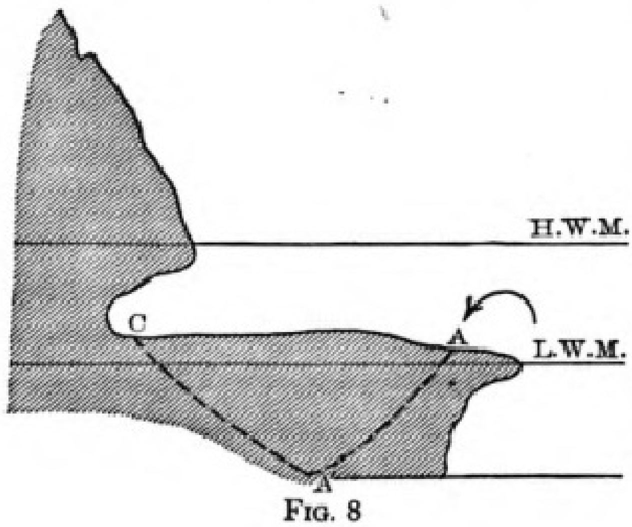


Fig. 8

Now before I had seen these Serpulæ atolls, I had come to the conclusion that the

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Hogsty Reef (atoll) [Fig. 11], five miles by two and a half, had been formed by the scouring of the surf, just

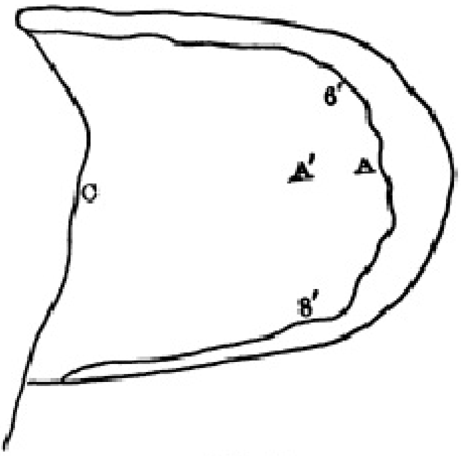


Fig. 9

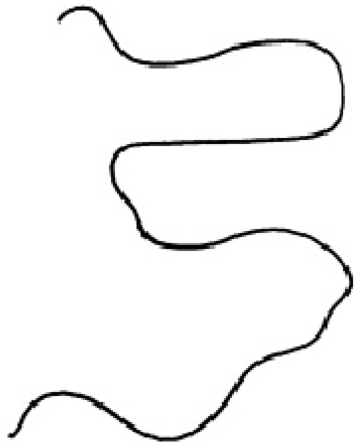


Fig. 10

in the way represented by the preceding crescent-shaped reef (Serpulæ Algæ atoll). The corals had grown and formed a barrier over which the surf broke and dug out the atoll. But the atoll was not formed by the growth of the coral during subsidence, as it is only a few feet thick on a sub-basis of æolian hills which have disappeared, and when that bank got a proper depth for corals, they flourished. One thing is very plain, that while to subsidence the present configuration of the Bahamas and Bermudas is due, that is a very different thing from saying that the reefs which surrounded the islands and banks as a thin veneer are the cause of the forming of the atoll-shaped islands keeping pace with the subsidence, when a few feet below the coral is found the æolian rock!!

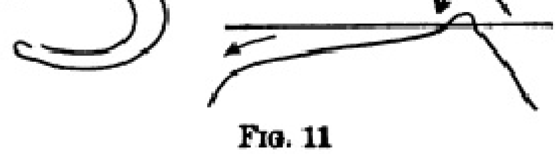


Fig. 11

I don't yet know what my plans are to be this early

Digitized by Google Original from UNIVERSITY OF MICHIGAN

summer — the Dolomites or Calumet — I much fear the latter.

Agassiz always intended to pay a visit to the Dolomites and see for himself if these limestones are coral reef rocks, as some geologists assert; but though the excursion was frequently contemplated, something always arose to prevent its actually taking place. On this occasion he developed some trouble with his throat, and the doctor considered that it would be unwise for him to go abroad and attend scientific meetings, so he spent his summer quietly at Newport writing up his reports on the Bahamas and Bermudas.

Agassiz's previous conclusions as to the probable method of formation of the lower coast of Florida were upset by his exploration of the Bahamas and Bermudas. In order to make a further examination of the Florida reefs he chartered the Clyde, an ordinary small tug with four berths in the cabin, which were occupied by the Captain, the Engineer, his son Max, and himself. He joined the boat at Key West in the middle of December, 1894.

On Board the Tug Clyde,
off Key West, Dec. 22, 1894.

"We are already halfway nearly down from the most northerly point, Key Biscayne Bay. We have had splendid weather so far, except last night going from Elliott Key to Cape Florida it was pretty rough for a couple of hours, but Max and I stood it well. I am more than pleased to have taken this trip. I shall have to modify my views on the Florida reef greatly and never could have done it had I not seen the Bahamas and the Bermudas.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

We have landed on the way up at all the interesting points on the Keys — and on the way down I am taking the outer reef and the reefs in the intervening channel.

When up at Key Biscayne it suddenly came across me that I had not been there since I was quite a small boy in the winter of 1850–51, when I distinguished myself by falling down the hatch of a Coast Survey vessel and being picked up for dead and laid out on the sofa of the cabin, where, however, I soon came to and have been pretty lively ever since. We then examined pretty nearly the same rock exposures I examined then in Father's company, only what he saw, and which I supposed he had seen, does not exist — but no one who has not seen Bahamas and Bermudas would have written differently. I have found the old reef which runs all the way from Key West to Key Biscayne, which has been elevated just like the Cuban reef, but only not more than six to twenty feet at the outside. Everybody has looked upon this inner reef as similar to the outer sea-faced [reef] formed in the same way. What I said about the Tortugas is, I think, all right, for I was not then looking at the Keys in the eyes of what had been dinned into me by Father."

On this expedition Agassiz was surprised to find that Lower Matecumbe Key was edged by a slightly elevated coral reef, which he was able to trace as far as the keys off the central part of Key Biscayne Bay. From his present investigations, combined with the results of the borings at Key West, he reached the conclusion that in Pliocene times the landward extension of what is known as the Pourtalès plateau stretched in a series of bars and flats from the outer reef of to-day many miles inland of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

what is now the coast line of the mainland. On these bars and flats corals began to grow in post-Pliocene times, and as the thickness of this reef is not over fifty feet, the greatest depth at which the corals began to grow was probably considerably less than the greatest depth at which corals are known to thrive.

The reef was slightly raised and then eroded, leaving patches of elevated reef and coral sand beaches; this sand has been blown up to form the æolian rock of the keys, which has solidified into hard ringing limestone by the action of rain or sea spray, while the coast line of the mainland he believes to have been formed in a similar way. He believed that the sounds that separated the keys from the mainland are due to the mechanical and solvent action of the sea, while the ship channel separating the outer line of reef patches from the main line of keys probably represents a sink of greater extension which the currents have swept clean and subsequently deepened. "Finally, it is upon the remnants of the old elevated reef that the present growing reef flourishes, forming, as it does in the Bahamas and Bermudas, a comparatively thin crust upon the underlying foundation rocks, which are now known to be Pliocene, and which occur at a depth considerably less than that at which reef corals are known to grow."

Griswold and others are of the opinion that the oölites of the mainland were laid down under water. Agassiz, on the other hand, considers them æolian, and explains their stratification by the action of rainwater containing carbonic acid on successive layers of coral sand, more or less mixed with quartz sand. The rain would take up a little lime, and on evaporation would

Digitized by Google Original from UNIVERSITY OF MICHIGAN

form successive crust lines of demarcation between the various layers of sand.

Agassiz again visited the region in 1908, when the quarry back of Miami and the cuttings of the railroad to the south had made some interesting sections which furnished material not available on his previous examinations. The results of this expedition were never published, but from his notes there seems no reason to believe that his views of the formation of that part of the Peninsula were materially changed.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

CHAPTER XIV

1896

THE GREAT BARRIER REEF

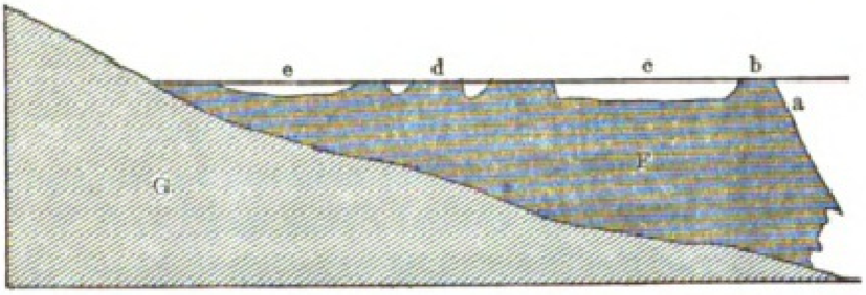
Agassiz selected the Great Barrier Reef of Australia for the goal of his next expedition, as he wished to determine whether the causes instrumental in creating the coral regions about the Antilles were as local as some of the scientific men of the old school believed. This great reef, stretching for hundreds of miles along the north-eastern shores of the island continent, seemed an excellent place for the purpose. Not only had Darwin especially cited the Great Barrier Reef in support of his theory, but J. B. Jukes, who visited it in the Fly, also concluded that the formation of the reef was due to subsidence. Judging from a magnificently illustrated volume on the Great Barrier Reef which appeared in 1893, W. Saville Kent also seemed to believe that the theory of subsidence must be true, because it had been adopted as an elementary axiom in the "leading Australian handbooks."

"The Voyage of the Fly," published by Jukes in 1847, gives a remarkably accurate description of parts of the reef. In order to explain its formation by Darwin's theory, Jukes makes use of the accompanying imaginary section.

Since reef-building corals will not grow much below twenty fathoms, the great mass of coral rock *F*, which the theory demands, could not possibly have been formed by corals growing up from the bottom. The supporters

Digitized by Google Original from UNIVERSITY OF MICHIGAN

of the theory, therefore, assume the land to have been higher at the time the corals began to grow, than at present, so that the coast line then reached the line of the outer reef *b*. As the land gradually sank, the corals grew up, keeping pace with the incursion of the ocean, finally producing the tremendous buttress of coral rock



a. Sea outside the barrier, generally unfathomable.
b. The actual barrier.
c. Clear channel inside the barrier, generally about fifteen to twenty fathoms deep.
d. The inner reef.
e. Shoal channel between the inner reef and the shore.
F. The great buttress of calcareous rock, formed of coral and the detritus of corals and shells.
G. The mainland, formed of granites and other similar rocks.

that overlies the sunken land, and stretches out from the present shore line.

Agassiz began the preparations for this expedition months in advance, and every detail was most carefully thought out and provided for. Indeed, he exercised the same careful forethought in the organization and equipment of all his cruises. Knowing the labor and care necessary to arrange for what he called "one of his own little trips," he was always amazed at the work it must have required to fit out for such a voyage, for example, as Nansen's exploration in the Fram.

A small cargo steamer, the Croyden, was chartered

Digitized by Google Original from UNIVERSITY OF MICHIGAN

from the Australasian Navigation Company. Suitable quarters for Agassiz and his assistants were built into the boat; she was fully provisioned for two months, and arrangements were made for insuring a supply of coal at points where it would be needed along the coast. Captain Tanner kindly took charge of the building of a sounding machine and deep-sea nets for the expedition. These, with a complete and extensive outfit for pelagic fishing, were forwarded in advance to Sydney. In the midst of the preparations Cleveland delivered his Venezuela message, which for the moment so strained the relations between the United States and Great Britain. The owners of the Croyden at once telegraphed, asking for a release from their contract owing to the prospect of war, but Agassiz telegraphed back laughing at their apprehensions. Through the State Department he obtained, from the Foreign Office in London, letters to the Governor of New South Wales and the officer administering the Government of Queensland, so that he everywhere received much courtesy, and every opportunity was offered him for carrying on his work.

Three assistants, Dr. W. McM. Woodworth, Dr. A. G. Mayer, both then members of the Museum staff, and his son Maximilian, accompanied Agassiz, who left for Australia via San Francisco early in the spring of 1896, reaching Sydney in the midst of the four or five days of Easter holidays. The Croyden was in dry dock waiting for her finishing touches, and he was much exasperated to find that nothing could be done till the end of the holidays. While waiting he made an excursion into the interior, where in common with other travellers he felt the dreary monotony of the great Eucalyptus forests, ran across a drive of wallabies, and had the luck to

Digitized by Google Original from UNIVERSITY OF MICHIGAN

see what the Australians call their bear, a tree kangaroo. He was much interested in some of the valleys so characteristic of Australia, whose structure has greatly puzzled the older geologists, but which he speaks of as simple enough to an American who has seen the large and small cañons of Colorado and elsewhere. Meanwhile the Croyden had started for Brisbane, where the party went by rail, joining the ship on April 16.

On Board the Croyden,
Townsville, Queensland,
April 22, 1896.

"To-morrow A.M. we put into Townsville where I shall mail this letter. We left Brisbane the 16th, P.M., and ever since until to-day we have had beastly weather, much worse than anything between San Francisco and Sydney. We dropped right into it [rough weather] the night of the 16th and by next A.M. made what is called "Wide Opening," which is seventy miles from Brisbane, and cut off about fifty miles of outside sea, so we had peace for breakfast, and anchored in the evening at the lighthouse of Break Sea Spit; then we went ashore, saw some natives, and after dinner put to sea so as to reach Lady Elliot Island, the southernmost reef, by daylight. When we got there it was blowing hard and raining, so there was no landing possible, and we kept on, passed the Bunker and Porcupine Islands, which are rather peculiar reefs, without chance of seeing them. So we put in for the night at Keppel Bay, where we had a good night and quiet dinner. The next day we remained there hoping for a change of weather, but none being in sight, we left at night for the next anchorage, the Percy Islands. When we got there we

Digitized by Google Original from UNIVERSITY OF MICHIGAN

were no better off, heavy sea running and no chance to see the reef, so we kept on to Whit-Sunday Passage, where we got yesterday A.M.

I fear I have brought a great deal too much material and supplies of all kinds, for unless the weather is very different from what it has been, and all say it will be, I cannot hope to do anything outside, and my reeling engine and sounding machine will be very little used. For such a long trip and so many men a larger vessel is wanted; there is no storage for one's clothes in the cabin — all has to be kept in valises and trunks and we have each one shelf to place the most urgent material. The food is very fair and the vessel an excellent sea boat. We are now in latitude 20 and it's getting warm, and pretty warm in the cabin at night."

TO MISS E. H. CLARK

On Board the Croyden,
Cairns, April 26, 1896.

Bad weather seems to pursue us since leaving Townsville. We have only had one really good day for work, and of course the day we spent coaling was perfect. Still the time is not all wasted, and I am learning a little something nearly every day. We manage to get a few things to look at from the beaches at low tide, if they are accessible, and land on the Islands when we anchor, where I devote myself to the rocks, Woodworth to collecting on the beaches, and Mayer to insects, and both Max and Woodworth bring their cameras in case there is anything of interest to photograph. Still I am getting frightened at the little work that has been accomplished thus far, and unless in the next month there is a radical change for the better, the expedition will be

Digitized by Google Original from UNIVERSITY OF MICHIGAN

noted as a failure. Still it won't be for any fault of mine.

We got this afternoon late to Cairns, but have not yet been ashore; the place as seen from the sea is quite attractive, stretching along the beach with plenty of trees separating the low houses. Our coming in caused quite a sensation — the population was evidently just coming out of church and they all flocked to the wharf to see us come to an anchor. The Captain has gone ashore to see the authorities and to make arrangements for our going to see the Barren River Falls, which are the most noted falls in Australia. Of course if the wind lets up we go out to the reef, which is only about twelve miles off from our anchorage. But to-night there seems to be no prospect of such good luck.

On Board the Croyden,
Off the Lark Passage,
May 5, 1896.

"At last we got off from Cairns last Sunday afternoon, after having wasted a full week there at anchor doing absolutely nothing except the little occupation we manage to get from drawing a rather interesting jellyfish which seems to swarm up in the estuaries of the Australian coast. Had we been weatherbound at any other port we would have fared better, as there would have been the railroad lines running inland, some of which lead to interesting mining districts where I could have spent some time profitably looking at mines. On getting away we had an excellent sight of the reef on the southern side of Trinity Opening, which showed nothing remarkable. The night we spent running north towards Cooktown; we had a good passage, then after breakfast attacked the two inner patches leading to the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

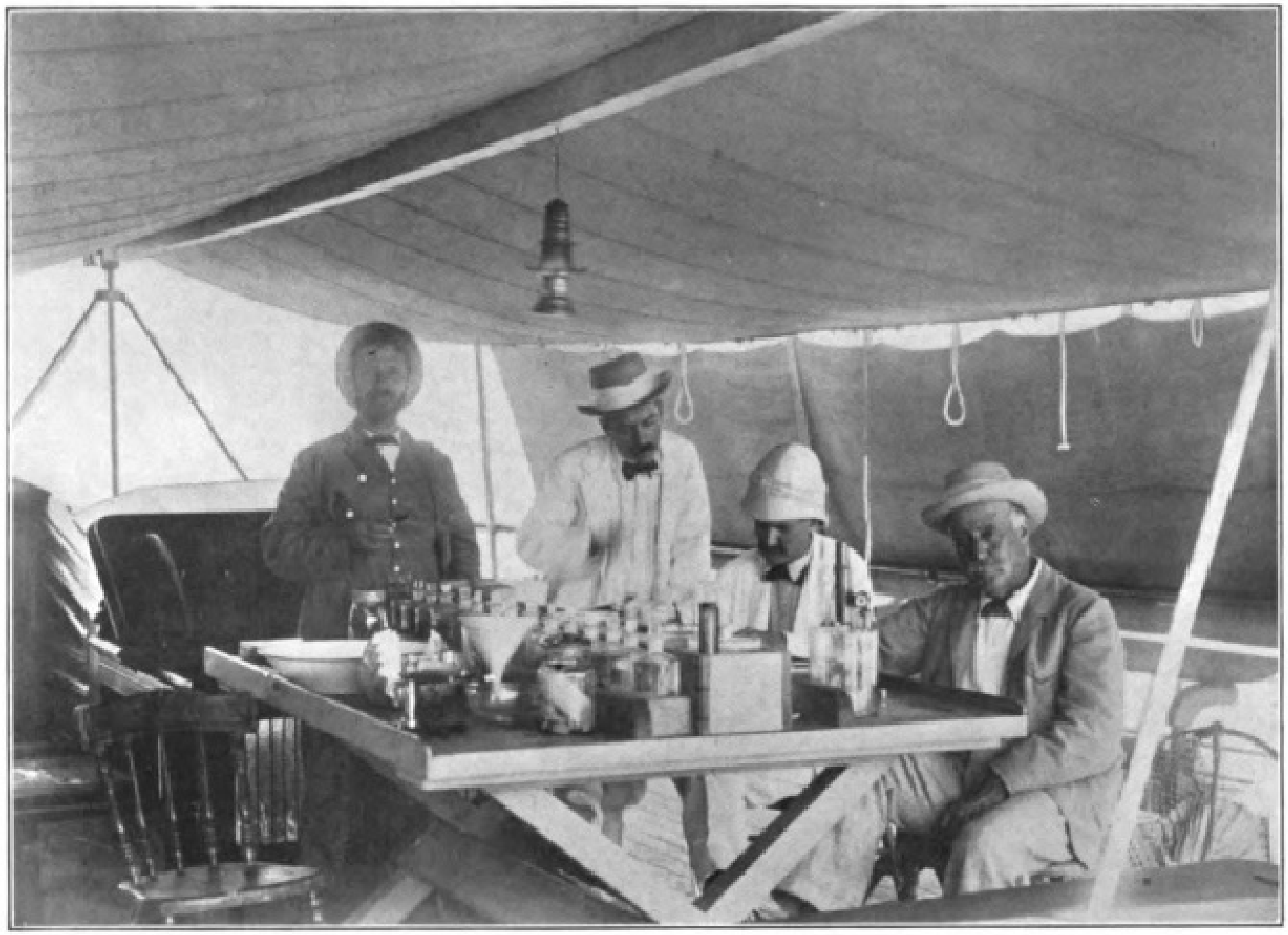
'Lark' Passage. There I began to have my eyes opened, and to get an explanation of the formation of the coral flat reefs. So that was most satisfactory; on the weather side of one of these reefs we got a glimpse of the corals, which were simply wonderful in the way of coloring, nothing like it have I ever seen. I wish one could get a photograph or a picture of such a brilliantly gaudy reef, but that is hopeless. While we were laid up at Cairns we also lost a set of very low tides on which I had depended to get some such fine photographs as those of Kent.

We are anchored for the night just under the lee of the thin line of the outer reef, upon which the surf is thundering. To-morrow morning we intend to go outside if the sea is not too heavy and do a little sounding and deep towing. We set up the sounding machine today and are ready to use it now. I shall depute Max to run it, for I hardly trust any of the men. They are none of them very handy and the boat men especially are pretty awkward, and my only safety lies in having Max at hand ready to take hold.

As we were off Cooktown we saw the missionary steamer, John Williams, go into the harbor. She has just come from New Guinea, and we hope to pick up quite a lot of New Guinea curios when we put into Cooktown, which will be as soon as the weather compels us to do so. We are going to try and examine all the reefs within fifty miles of Cooktown before we refill our water tanks and lay in the last supply of ice we shall indulge in till we get on board the Ocampo for Hong-Kong.

"May 9th — Cooktown. Got here last night after a few hours of work only and the rest fighting against the trades. After all, the Admiralty was right — this is

Digitized by Google Original from UNIVERSITY OF MICHIGAN



LABORATORY ON THE DECK OF THE CROYDEN

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

no time to come. It is just as I feared in the region of trades — while they blow, nothing can be done, and you get here and there a good day. With the prospect of wind before us, it is hopeless to do anything till end of *July!* Hereafter I shall stick to Admiralty advice. It's a bitter experience to have wasted so much time and accomplished so little after all this flourish of trumpets. But I shall be glad to get home and turn down this leaf of failure and forget all about it in the pleasure of getting back."

TO SIR JOHN MURRAY

On Board the Croyden,
Cooktown, Queensland,
May 16, 1896.

I am thankful you did not come and join this expedition, as I hoped you would. I have never been connected with a greater fizzle. Since we left Brisbane, more than a month ago, we have had just five days of good working weather. The corals here are superb, and I had no conception from the West Indian reefs of what a reef can be. The gigantic masses of the Astraeans, Meandrina, etc., dwarf the largest masses of the Florida and Bahamas, and all within six to seven fathoms, so that with a water glass one can see the whole reef. The most striking characteristic is the absence of Gorgonians, which form so marked a feature of the West Indian reef. They are replaced by the Alcyonaria tribe and by the sponges and huge Actineans, the like of which I have never dreamed of till I saw them figured in Kent's book. Why he advised me to come here during the time of the trades I cannot understand. Wharton [1] warned me about

[1] Admiral Sir W. J. L. Wharton, of the Hydrographic Department of the British Admiralty.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

the trades, and I knew enough of trades to know that when they blow very little can be done. Yet when I cabled Kent he reaffirmed his opinion, and got Wharton to agree with him to boot.

All captains here say I should have come in November and December before the hurricane season when every day counts for work almost. It is hot then but calm, now it is not hot and anything but calm. It is aggravating, to say the least, to lead such a failure, and the more so, as I never went on any expedition better equipped in men and material, and hoped besides the reef examination to make a great collection of pelagic material. But I hauled twice only, and then it was blowing so hard that in so small a boat as the Croyden I did not dare to do much for fear of carrying all my tackle away the way she rolled and pitched. I have, however, seen enough of the reef to satisfy myself of its mode of formation, and I fancy the subsidence people will not have much ground for support. It is very much like the Florida reef, only on an immense scale.

I intended to have pushed through to Thursday Island, in spite of the bad weather which everybody who knows anything prophesies, but the steamer I was to take at end of May from there for Hong-Kong has been lost in China Sea and is replaced by a cargo steamer carrying no passengers. The same is the case with the Batavia steamers—they take no passengers; so that unless I could stay till end of June there was no chance of my getting away from Thursday Island unless I was prepared to buck five hundred miles of trades in a small steamer of little power, like my boat. That I could not see my way to do. So I give up the trip and go back via Naples, the 27th.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

It is fortunate that there is no one except myself on whom this failure falls, and that I have not to account for such a miserable expedition to any one, so that I can now turn down this wretched page and think no more of it except when I write a few pages giving an account of the trip. I have had a pleasant yachting trip and am very sorry for my two assistants whom I hoped would gather no end of pelagic stuff to work up when they got home. They have taken it very good-naturedly, for it's no joke for them to lose, as they have done, five months of other work.

Agassiz's reasons for disagreeing *in toto* from the opinion of Jukes that Darwin's theory was applicable to this region may be summarized as follows: In the first place, the "unfathomable depth" of the sea outside the barrier, of which so much is made in coral-reef discussions, simply does not exist. The slope outside the reef is, in fact, more gradual than the outer slope of the extension of this great continental plateau farther south, where there are no corals. Furthermore, the space between the outer reef and the present coast line is studded with islands, which would give Jukes's imaginary diagram an entirely different aspect, as it would show a series of peaks cropping out and connected with the mainland *G*. (p. 311.)

The deeply eroded flanks of the coast mountains, the existence of extensive high table levels, characteristic of the adjacent islands also, convinced Agassiz, when taken together, that the coast of Queensland has for a long period been subjected to a very extensive denudation and erosion, and that the islands were once a part of the mainland. This supposition is fully confirmed

Digitized by Google Original from UNIVERSITY OF MICHIGAN

by what is known of the geology and botany of the mainland and the adjacent islands. Many of the more distant remnants of the former mainland are now mere islets flanked by extensive flats, or they are simply flats eaten away to beneath low-water mark.

He was thus led to the conclusion that all the flats and reefs lying between the outer line of reefs and the mainland are but the remnants of former islands extending to the eastern edge of the continental plateau, islands which once formed a part of the eastern coast of Queensland, but which have by erosion and denudation gradually been separated from the mainland and reduced to the flats forming the outer reef flats of the Great Barrier Reef.

The reports of the Queensland colonial geologists seem to prove that there was a very considerable subsidence in Cretaceous times, followed by an elevation of the beds then laid down, as exemplified in the desert sandstones. The outlines of the present coast line and its submarine extension Agassiz took to have been shaped by this subsidence and subsequent elevation, and by the erosion and denudation to which these beds, since their elevation above the level of the sea, have been subjected for so long a period. It is on the upper part of these submarine slopes, of a former geological period, but modified by erosion and denudation up to recent times, that during the present epoch corals have obtained a footing and built up the Great Barrier Reef of Australia. Thus, instead of Jukes's tremendous buttress of coral, there should be but a comparatively thin veneer of coral rock overlying the denuded land.

Certain puzzling peculiarities of the reef Agassiz explained as follows: — There is every reason to believe

Digitized by Google Original from UNIVERSITY OF MICHIGAN

that the outer strips of flats, now worn to below the level of the sea, were at no very distant time (geologically) covered by a reef which was elevated from ten to twelve feet above the highest level at which corals are now growing. Gradually this elevated reef was eaten away by the action of the sea, and this accounts for the small fragments of dead coral which are scattered over the outer reef flats. On the inner reef flats, where the process has not gone on quite so long, he found the elevated reef eaten into "negro heads;" while yet nearer the mainland there are still portions of the reef that have not been so eaten. Thus the upper part of the present reef may be said to form a crust over the dead and denuded elevated reef, which forms the core of the reef.

The same erosion and denudation that formed the great submarine plateau of Queensland, undoubtedly has separated North Queensland from New Guinea, and left the shallow continental shelf stretching between them. Finally, he concludes that if the Cretaceous subsidence and subsequent elevation of the beds then formed in Australia could be traced sufficiently far to the eastward, the same erosion and denudation of these beds would go far to explain the existence of the banks, islands, and archipelagoes of the Southern Pacific.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

CHAPTER XV

1897–1898

THE FIJIS

As soon as Agassiz had returned from Australia, he began to consider what region would be best suited for a further investigation of coral reefs. With the advice of Dana and Admiral Wharton, he selected the Fiji Islands, for they appeared to be remarkably rich in a great variety of coral formations. At once he started preparations for the voyage. He chartered from the Australasian Navigation Company the steamer Yaralla, of about five hundred tons; Captain Thomson, who had commanded the Croyden, was again put in charge. The summer before he left, all his equipment and materials for preserving his collections were shipped direct to Sydney. He also planned to take with him a number of the various self-closing nets known to the scientific world, in order to compare them with his old love, the Tanner net.

While these arrangements were in progress, he spent the spring of 1897 in visiting the last of his unsuccessful mining ventures in Mexico. Three days on horseback from the picturesque little city of Culiacan brought him to the mine. On leaving, he continued his journey across the mountains to Jimenez on the Mexican Central Railroad; and from there went to the City of Mexico to arrange some business matters.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

TO SIR JOHN MURRAY

CAMBRIDGE, May 16, 1897.

On my return from Mexico I find yours of the 9th of February. I have been way up on the west side of the great Mexican Plateau, anywhere between 8500 and 9000 feet, riding mule-back, camping out and living outdoors and getting into fine shape. I am now as tough as the mules I 've associated with, but I hope not as obstinate! Food was not all that was desirable and our cook, an old cowboy, would not pass as a French chef. Max and a friend of mine composed the party; we were all ready for anything, and finally managed ten to eleven hours in the saddle a day without being the worse for it. I quite regretted getting back to civilization. I move to Newport to-morrow, when I shall try and finish my Australian Report before starting for the Fiji. All my preparations are now made for that. I have a fine twin screw steamer, 200 feet on water line, lots of room — she will meet me at Suva end of October. I am going to have a launch and take with me a boring apparatus and the most skillful man of the Diamond Drill Company. We go prepared to go to 350 feet, and I shall put a hole in an elevated reef and in the edge of an atoll if I can find solid ground anywhere to start. To obviate difficulty of water supply, I take a kerosene motor with me to run the Diamond Drill. The company are of course interested in the success, and they say that the man who goes with me is noted for always landing on his feet. I take with me the same assistants I had in Australia, and trust we shall have better luck. Still I am going prepared to be more or less disappointed. I have just published a fine Monograph on Crinoids by Wachsmuth and Springer,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

which you will get in due time. Also a Memoir by Milne Edwards on some more of Blake Crustacea, and a Memoir by Maas on the Albatross Medusæ, which should come out shortly.

The members of the expedition left Boston on October 9, 1897, to join the Yaralla. The evening of November 6 saw them at the little town of Suva, the capital of Fiji, with its one street of shops, set in a great sweep of low sharp hills, their slopes thickly wooded with tropical vegetation. Here they found the Yaralla, which had been waiting for ten days. The next morning, Agassiz went ashore to present his letters to Sir George O'Brien, the High Commissioner; here he found in Mrs. Allardyce, whose husband was in charge of the native Department, an old acquaintance with whom he had once made a passage from Bombay to Naples. In the midst of his scientific notes one finds, as unexpectedly as a joke in a mathematical table, the following entry: "Went to see Mr. Allardyce — queer to see man servant with nothing but a loin cloth round him — he served tea to us and two lady callers!"

Agassiz supposed he must be coming to a characteristic area of *subsidence*, since, according to Darwin and Dana, there is no coral reef region in which it is a simpler matter to follow the various formations. For this reason he had thought that one of the atolls here would be an excellent place for boring to decide the thickness of the reef. The preceding letter to Murray suggests, however, that his surprise could not have been entirely unexpected, when he found, a mile out of Suva, an *elevated* reef about fifty feet thick and one hundred and twenty feet above the level of the sea!

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Agassiz was fortunate in securing the services of Captain R. Cocks as pilot, especially recommended by Sir John Thurston, the late Governor of the Fijis, who had taken the greatest interest in the plans for the expedition. This pilot proved invaluable, as he knew every nook and corner, and just what to do in any emergency. The inset in Chart 2 at the end of the volume shows the track of the Yaralla. It comprised practically all of the group, with the exception of some of the outlying islands, and the region to the north of Viti Levu, the largest of the islands, on the south of which Suva is situated. Vanua Levu, the other large island, the ship merely grazed as it steamed through Somo Somo Strait.

Leaving Suva on November 8, the Yaralla made for Mbenga, to the southwest of Suva, a volcanic island about five miles across, rising about fourteen hundred feet above the sea, and surrounded by a vast barrier reef some thirty miles in extent. Here Agassiz passed several days examining the reefs, and then started for Vatu Leile, the next island to the west. About halfway across, the weather began to look dirty and the glass started to fall so rapidly that it was thought best to put back to Suva which the ship reached just before the storm broke.

The next and longest run was so planned as to offer a study of at least one or two examples of each type of island, and of the different types of atolls, barrier and fringing reefs in the group. Proceeding through the group to the northeast, Agassiz then ran down along the line of smaller islands, which form the eastern or Lau group of the archipelago, and afterward worked his way westward back to Suva. The nights were usually spent at anchor, sometimes under the friendly lee of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

a point, or perhaps between a barrier reef and the shore of the island that it encircled, close to some native village; while again the pilot, watching for shoals from the masthead, would guide the ship through a narrow passage between the breakers into some quiet lagoon; and once she anchored in the crater of an old volcano, whose giant walls towering about her formed the island of Totoya. Curiously enough, the Yaralla visited Oneata exactly fifty-seven years after Wilkes, the first steamer to go into its lagoon since 1876.

The opportunity of seeing something of the natives was not the least interesting part of the expedition. The English have had the good sense to leave them very much undisturbed, and allow them to go on as they always have, so they are among the finest examples of what the South Sea Islander was before he fell into the hands of missionary and trader. As the ship steamed along some island, with scattered huts lying in the shade of the palms that overhung sandy beaches, her appearance would cause the greatest excitement among the natives, who ran wildly along the shore as she passed. Anchoring at the mouth of some pretty little bay at whose head clustered a tiny village along a coral sand beach, the explorers would go ashore to find the whole village, clad only in loin cloths, waiting to receive them. The chief would lead them to his house of reeds, with its high stone foundation and steep thatched roof; entering, by means of a flat log, in which notches had been cut for steps, they would find themselves in a large room whose walls and roof were hung with tapa and matting. Some dozen girls, the top of their heads clipped and their ringlets entwined with flowers, would squat down on the floor and begin one of the curious chant-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

ing songs of the country, shyly, at first, but warming up as they proceeded, clapping their hands to the rhythm, and swaying to and fro with all kinds of graceful motions of the arms and bodies. When the song was ended the men would be given tobacco — the women a few trinkets or a little money, some of the boys looking-glasses, and with mutual good feeling the party would break up.

At night, when the ship came to her anchorage, the chances were that a canoe load or two of natives from some neighboring village might put off. They would be shown all over the ship, whose various wonders they saw with the greatest astonishment, while the kindly treatment they received evidently filled them with delight and surprise.

The following is an extract from Agassiz's journal written shortly before returning to Suva: —

"Have been working pretty hard ever since I left Suva, getting up at 5 A.M. to see what there was to be seen in going in and out of lagoons or anchorage; used to have a cup of coffee and run round in pajamas till time to get ready for breakfast — to make up went to bed early, generally 8.30, and have never felt better in my life — sleep well as usual. Generally spend time after coffee measuring distances for the day's work or run, so as to make a programme and find shelter for the night; everybody joins in and finally we get the most time available for work at any place, and only twice have we been scrimped for time, the two days when we made two long stretches dead to windward against a huge ocean swell, which cut us down to less than seven miles. This boat is an excellent sea boat against the wind, but rolls more than I like when going broadside to the sea."

Digitized by Google Original from UNIVERSITY OF MICHIGAN

The Yaralla reached the harbor of Levuka, on the island of Ovalu, the night before the great swarm of Bololo was expected. Leaving the ship early next morning in a boat with a native crew, Agassiz and his assistants had scarcely reached Bololo Point, some two or three miles off, when the water became thick like vermicelli soup with this curious marine worm. The natives, who had gathered for miles in anticipation of the event, immediately put out in canoes, and men, women, and children waded out on the reef with nets and all kinds of utensils to catch the Bololo, which they consider a great delicacy, eating them raw or cooked with breadfruit. After a time the swarms vanished as suddenly and mysteriously as they appeared.

This great swarm always occurs in the last quartering of the moon in November, and is eagerly awaited by the natives, who can tell by certain signs when to expect it. Only recently had this curious phenomenon been called to the attention of naturalists. It proves to be the marriage swarm of a species of marine worm, living in the crevices of the neighboring coral reef, who throw off their sexual segments into the adjacent waters. After the discharge of the sperm of the males and the ova of the females, nothing is left but shrivelled transparent skins, hence their sudden disappearance.

TO SIR JOHN MURRAY

ON BOARD THE YARALLA,
SUVA, Dec. 3, 1897.

Hurrah! I have been and gone and done it, as we say in Yankee slang. We have just come in from nearly a month's trip round the islands of the Fijis, and a more interesting trip I have never made. I have learned

Digitized by Google Original from UNIVERSITY OF MICHIGAN

more about coral reefs and islands than in all my expeditions put together, and it looks to *me* as if I had got hold of the problem of deep [lagoons of] atolls, and of the history of the coral reefs of the group. But I 'll not go into details now except to say that I am more than ever satisfied that each district must be judged by itself, and that no such sweeping theory as that of Darwin can apply to coral reefs as a whole, or even to atolls. I don't believe from what I have seen that a single atoll in the Fijis has been formed by subsidence! — Darwin and Dana to the contrary notwithstanding. This is eminently a region of elevation at least to *eight hundred feet!* and subsidence has never shaped the reefs here. Without my experience in the West Indies, etc., it would have been impossible for me to have got a proper and correct idea of the Fiji Islands and their reefs. But I will not go into details until I get through here.

I only hope I shall have as good weather as we have had, not a day lost, working hard from 5 A.M. till we came to anchor for the night, and often steaming at night the huge stretches to save time. The Yaralla has proved herself eminently well fitted for this kind of work, and had the Croyden, in which I cruised along the Barrier Reef, been as good a boat, I could have bucked the trades and felt safe as I do here. She is very comfortable; we are well cared for, and have all been getting as black as the natives, from whom we can only be distinguished by the amount of clothing we wear! Besides coral work, we have greatly enjoyed seeing the natives in their villages, of which we have seen some of the best specimens. The islanders are the most friendly, jolly, and hospitable people, fully up to jokes, and most grateful for the smallest kindness. We

Digitized by Google Original from UNIVERSITY OF MICHIGAN

were daily overwhelmed with them, and sent them off usually happy and full of food and presents.

The scenery is also very beautiful, so that all in all we are enjoying every minute and glad to have done the outlying and most distant parts, so that now we shall be within easy reach of Suva in case of a blow.

I left my party for boring at Wailangilala, where they are well settled for six weeks; when I left them they had got going to eighteen feet in *sand*. But I look upon this boring as a mere experiment. Boring to be of any good must be in a recent coral reef like that of Florida or a fringing reef like that of Honolulu — where outside conditions have had no influence, and I shall tackle that some time and some where.

By the way, David, in a letter I find here, says the *reef proper* was only forty feet![1] Judging by the reporters' accounts in the papers, they made it the full depth of the bore, but I shall give them a dose they do not expect, and the theory of subsidence will, I think, be dead as a doornail and subside forever hereafter.

The little island of Wailangilala, in the northeast of the group, seemed admirably adapted for the purpose of boring; a low tiny island about five cables long, covered with shrub and cocoanut trees, that rose on the northeastern rim of a reef of the same name nearly nine miles around, enclosing a roughly elliptical lagoon. The island had the added advantage of having a lighthouse whose keeper was able to furnish shelter for the boring crew. Here a party of three white men and four natives was landed with the boring apparatus and pro-

[1] Refers to the boring made at Funafuti in the Ellice Islands, which will be mentioned later.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

visions, while the Yaralla steamed away, to return and pick up the men later.

On going back to Wailangilala, after he had seen something more of the elevated limestones so common in the group, Agassiz found the drill had reached the elevated limestone at a depth of about fifty feet, and stopped the work about thirty feet lower. For, as he says, "Of course it seemed foolish to go on boring here when it is so simple to get at the face and slopes of elevated reefs and study their composition *in situ* on a large scale and not from a core, reefs of which the underlying strata can be seen to be volcanic rocks as at Kambara, Mango, Fulanga, Vanua Mbalavu, and Suva Harbor and approaches."

The boring convinced Agassiz that the island was a fragment of one of larger size which once covered the whole area of the lagoon. For the northern extremity of the atoll was less subject to the destructive agency of the waves created by the southeast trades; so that here there was left a wider reef flat, upon which Wailangilala and another diminutive island represented the only dry land not worn away by the action of the sea.

Agassiz's next trip took him to the islands of Ngau, Nairai, and Ovalu, to the east of Suva, and included the tiny island of Mbau, close to the shore of Viti Levu, once the most important place of the Fijis, and crowded with houses. This was the home of the last great chief Thakombau, who ceded the islands to Great Britain.

After again touching at Suva, Agassiz proceeded toward Nandronga, whence he writes on December 8: "We got here this noon, our most westerly point, a pretty little harbor on the north coast of Viti Levu. The trip from the Mbenga passage has been most inter-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

esting and has confirmed all I have seen elsewhere in the group. We are now going again to Vatu Leile, where we had no chance of taking good photographs, and then examine three or four little harbors between here and Suva, and then I *am done!* except towing."

TO WOLCOTT GIBBS

ON BOARD THE YARALLA,
SUVA, Dec. 15th, 1897.

Here I have been at work now nearly six weeks with only a couple days bad weather, and I have been most successful! It's by far the best coral reef expedition I've undertaken, and were I to stop to-morrow I should feel more than repaid for the time and outlay involved. We have seen a good deal of the natives in their villages and found them most interesting. They are jolly, hospitable, and friendly, and it seems hardly possible that it is scarcely fifty years since Wilkes and their great King, Thakombau, had such a row! We have lunched with his son who is a great swell (he does not look so), and who lives in the finest house in the Fijis (native house, of course). He enjoys a pension of £500 from the English Government. When we saw him he had just come back from a fishing trip, was dressed in a loin cloth, his hair daubed with lime, and his face blackened, and in every way was not a prepossessing figure.

I have learned more about the coral reefs during the past month than in all my previous expeditions, and think that I now understand the causes which have brought about the existing state of things (in coral reef ways) in the Fijis. Had I seen these islands I should not have come here to bore. Whatever results are obtained will not help to settle the reef question, and our

Digitized by Google Original from UNIVERSITY OF MICHIGAN

English friends who are howling for joy at the results of the boring in Funafuti will be greatly surprised when they hear from me. I shall send in a week to see how my man is getting along. I left him on a small atoll in the northwest part of the [Lau] group called Wailangilala; as long as he is there I will let him bore for another month, but his results will in no way affect the question. When I came here I took it for granted that Dana's and Darwin's premises about the coral regions of the Central Pacific were correct and that this group of islands (Fijis) was in an area of subsidence. You may judge of my surprise when I found that the Fijian is an area of elevation, and in one day I've seen more of the thickness of elevated reef than I could have in a couple of years of steady work. I cannot understand how Dana ever made such a mistake, for he was in the group quite a while, but Darwin's observations were all theoretical and based upon chartographic study in his house, a very poor way of doing, and that's the way all his coral reef work has been done. He never was more than ten days in a region of reefs and thought out everything he has written. I never could see how his theory has got such a hold with so little holding ground. I shall now finish my time by making excursions of a few days from Suva as a centre and be within hail of port in case of a hurricane.

On Board Yaralla,
Suva, Dec. 17, 1897.

"I was reminded this A.M. that I had turned the corner of 62! — by Max and Woodworth, who are arranging a dress dinner in the cabin for celebrating the day! Since I wrote you we have done a lot of odds and ends from Suva as a base, and have done quite a lot of deep

Digitized by Google Original from UNIVERSITY OF MICHIGAN

towing and bagged some very nice things. But I have given up all idea of testing the deep-sea nets; it would take too long, and be too hard work; for the same reason I have also given up soundings. Both that kind of work all falls on me and none of the party understands the management of the nets or of the sounding machine, and I have not got the courage to do all this myself. It's a very different matter to do it in the Albatross, where the officers and crew know just what is to be done; but I am not up to it alone. We have been packing up our collections as far as we have got, and what with our specimens, utensils of natives, and corals which I bought, we have got quite a lot of boxes ready to go back, quite a contrast to the Australian trip, already about fifteen dozen hermetical vials of tow stuff! We have already begun to dismantle some of the equipment which we are not likely to use again.

We had a most successful little trip this A.M. to celebrate my birthday. We started at 5 A.M. for Mbenga, the first atoll we examined on leaving Suva, but from which we were driven by a squall. We got there at breakfast, the sun out brilliantly, and we took a new set of the photos, which had miscarried the first time. I was quite anxious to have the photos, as the island is one of the prettiest, and most characteristic, of the group, and we had tried twice before to get photos without success.

You have no idea how prettily Max and Woodworth decorated the cabin with palm leaves and bright leaves and tree greens and masses of flowers. The ceiling was hung with all kinds of flags, so that there was not a particle of the woodwork of the cabin to be seen. Mayer got up some programmes, which were appropriate for each individual. . . .

Digitized by Google Original from UNIVERSITY OF MICHIGAN

The rain is coming down to-day in torrents and we are tied to the wharf — we have had nothing but rain — rain — rain, as it does in the tropics, but I am thankful for the good time we have had. We have been packing, and I have also looked over my notes and written out a little, enough to make a beginning of my report. We expect to go on shore the day after Xmas, while the Yaralla is off at Wailangilala. We have already sent a lot of stuff on shore to work, and have arranged very comfortable quarters at the hotel, shutting off one end of the piazza as a workshop and laboratory. We have kept the kerosene launch as a boat, and might, if the weather is decent, do a good deal of work on the reef flats, and towing. There are quite a lot of jellyfishes here. Our photographs have now all been developed and are very fair; between Max and Woodworth I ought to make an excellent selection for my final report."

Agassiz left Suva on January 13, and spent a few days at Honolulu. When there he was fortunate in being on the spot while Mr. McCandless, who made a business of diamond drilling, was boring an artesian well. Down to eighty feet nothing but recent reef coral rock was encountered, but from that point to a depth of over three hundred feet the limestone was of a very different character. It contained but few corals, being composed almost entirely of shells of mollusks. When Mr. McCandless's attention was called to this, he assured Agassiz that this lower limestone was identical with those he had spoken of to Dana and to him in 1885. This would seem amply to confirm Agassiz's contention that they do not belong to the same period as the superimposed corals.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Writing from Honolulu at this time (1898), he says: "They are now boring a well and have got down to 120 feet already, and have just got through the modern reefs and are now on what the contractor calls an old reef, which is nothing but a mass of shells. This practically knocks out all the evidence there was in favor of subsidence derived from the [previous] boring holes. . . . There are forty wells down 400 to 1100 feet, but unfortunately no samples of these worth anything have been kept. All that was limestone they have called coral, so that both Dana and I were fooled, he in one way and I in another, but I suppose that nothing I can now say will obliterate the things that have been said about these wells, and which mean nothing except complication of the subject."

Some years later he writes: "The borings for artesian wells passed through thirty to fifty feet of recent coral reef to enter Tertiary beds, in which a few corals were found, and which alternated with beds of volcanic ashes or mud. In the Tertiary beds Dana saw the continuation of the recent reef, while to me the Tertiary beds meant a succession of events which in no way affected the structure or mode of formation of the thin crust of the recent coral reef forming the fringing reef of Oahu, of Pearl Harbor, or of Kaneohe Bay."

Agassiz's study of the Fijis but strengthened his conviction that there is no general theory of the formation of coral reefs of universal application; each district must be studied by itself. In the Fijis, he considered elevation and subsequent erosion to be the causes that have fashioned the steep slopes of the islands and reefs, and not the thin crust of corals which thrive upon the reef flats forming the substratum of the modern reef.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

This eroded substratum, slightly modified by the growth of the crust of recent corals found upon it, is in the Fijis composed either of volcanic material or of elevated limestone, whose sea faces, following the ancient slope of the land mass, represent its former extension.

The islands of Fiji may be divided into three classes — elevated limestone, partly elevated limestone and partly volcanic, and volcanic. As a rule the volcanic and limestone islands are easily distinguished at a glance, the gradual slopes of the volcanic peaks contrasting strongly with the flat-topped summits and precipitous cliffs of the limestone islands.

The limestone cliffs, many hundreds of feet in height, plainly attest a great upheaval of the region; while the outlines of the islands, deeply furrowed by gorges and valleys, the sharp and serrated ridges separating them, the fantastic outlines of such peaks as those of Viti Levu and Vanua Levu, and others, all attest the extensive denudation and erosion that has been going on in the group for a very considerable period of geological time.

Since the volcanic islands would naturally be eroded to a less extent than the limestone, it is not surprising to find that the larger islands, like Kandavu, Taviuni, and Ovalau, are of volcanic origin; while some of the limestone islands have been almost entirely eroded. So that of many which once occupied the area of present lagoons, like Ngele Levu, there is left only here and there a small island to attest the former existence of the more extensive elevated limestone, that once covered the whole area of what is now an atoll.

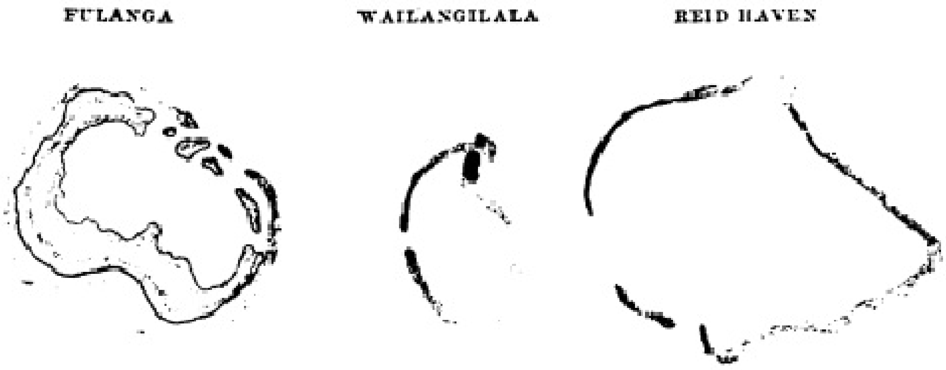
The elevated limestone islands, such as Maiau, Tuvuthá, and many others, with bluffs of coralliferous limestone, have been by some considered as elevated fossil atolls

Digitized by Google Original from UNIVERSITY OF MICHIGAN

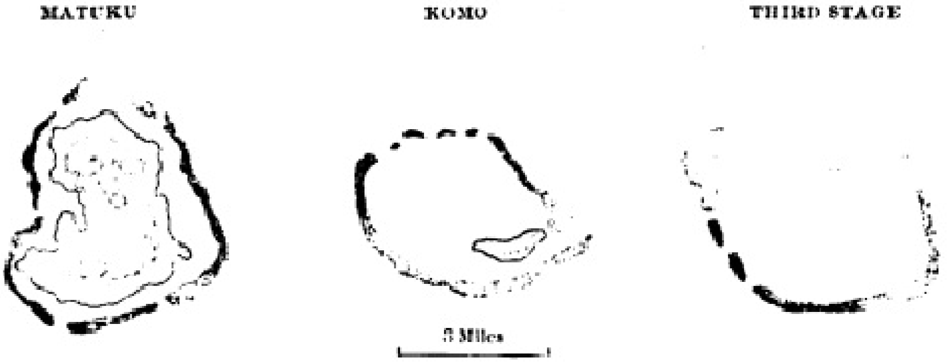
because of the existence of a depression on the summit which was looked upon as the remains of a lagoon. Agassiz, however, did not believe these cuplike formations represented the floors of old lagoons, but considered them similar to the gigantic banana holes, as they are called, found in the Bermudas. He attributed such depressions to causes now going on and looked upon them as the first process in the erosion of the islands. The decaying vegetation, thickest in the interior of a limestone-island plateau, on settling in any inequality or fissure on the flat top of an island, forms acids. These greatly intensify the solvent action of the rains, which, percolating through the mass, carry off the limestone. A drainage from the edges toward the centre is established, and we get the beginning of the saucer-shaped basins so characteristic of the elevated limestone islands of Fiji. At first there is but a slight depression; this gradually deepens, till when the sea finally breaks in we have an island like Fulanga, about whose outer flanks corals have established themselves. A further process of erosion would result in wearing away this land until nothing remained of the original island but a few islets rising from a denuded reef as in Wailangilala. And finally when the process is carried still further, nothing is left of the island but a submarine ridge upon which corals have established themselves, like Reid Haven. (See colored plate, Figs. **1**.)

Where islands, composed either of volcanic material or limestone, have been eroded to form a submarine *platform*, upon which corals have obtained a footing, Agassiz would explain the existence of the lagoon as follows: — The great rollers piled up by the trade winds break over the outer rim, protected by a more vigorous

Digitized by Google Original from UNIVERSITY OF MICHIGAN



FIGS. 1. THE DEVELOPMENT OF AN ATOLL FROM A LIMESTONE ISLAND



FIGS. 2. THE DEVELOPMENT OF AN ATOLL FROM A VOLCANIC ISLAND

U of M

FIGURES SHOWING THE DEVELOPMENT OF AN ATOLL

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

growth of coral. The water thus poured in forms a hydraulic head that can escape only through the openings in the outer reef flats. It becomes charged with particles of lime or other material, derived mainly from the mechanical disintegration of the corals or substratum forming the surface of the reef, and also in part from the chemical disintegration due to the action of sea water which rots and dissolves the limestones of the reef. Soon there exist all the elements of a modified gigantic pothole, from which the churned material is carried out by the currents flowing through the entrances into the lagoon. Where corals have established themselves about an island on the submarine platforms formed from it by denudation and submarine erosion, he would explain, in very much the same way, the passages between the islands and the barrier reefs.

Given a comparatively small volcanic island upon whose eroded platforms corals have established themselves, the first result of the processes described above would be an island with a barrier reef like Matuku. As the denudation and scouring continued, they would cause the disintegration of most of the land, as in Komo. The final effect would be the total disappearance of the land, leaving a lagoon enclosed by a reef. In this last stage the position of the atoll near volcanic islands would often be the only guide to the character of its formation. (See colored plate, Figs. 2.)

There is still another method by which some of the atolls have probably been formed. In the group are two islands, Thombia and Totoya, both volcanic peaks into whose craters the sea has broken through some point in their walls, and formed lagoons. Across the opening

Digitized by Google Original from UNIVERSITY OF MICHIGAN

of each island stretches a coral reef. After seeing the coral reefs growing on the denuded rims of these islands, Agassiz was inclined to revert to the old opinion that some of the lagoons of atolls represent the remains of extinct craters. He found nothing unreasonable in the suggestion that many of the small, fairly round atolls, and others rising from great depths and isolated, are the denuded rims of such craters as Thombia, or, if larger, Totoya, upon which corals have obtained a footing.

The existence of some deep lagoons has been cited, by the supporters of the theory of subsidence, as a proof of its truth. Agassiz pointed out that if the theory were true, all large lagoons should be deep. Lagoons of considerably greater depth than that at which corals can thrive he believes may be explained as the remains of old craters into which the sea has broken during the washing away of their walls. In support of this theory he cites the fact that Haleakala in the Hawaiian Islands, Aso San in Japan, and several volcanoes in Java, have craters of a diameter fully equal to a number of the Fiji atolls.

Great bluffs are a characteristic feature of the limestone islands of Fiji. Some of these rise to a height of a thousand feet, and attest the elevation that has taken place in that region. The faces of these bluffs are evidently coralliferous. Agassiz found it was almost impossible to collect corals from the exposed surfaces of these cliffs with the appliances at hand, as the limestones had become so hard that a hammer produced no impression on them, and the corals were so well embedded that they could not be cut out.

From such examination as he was able to make, he

Digitized by Google Original from UNIVERSITY OF MICHIGAN

thought these bluffs were late Tertiary, a conclusion confirmed by Dr. W. H. Dall's examination of the fossil mollusks that the former collected from them. Agassiz admitted the difficulty of determining the method of formation of these elevated coralliferous limestones of *a former geological period*. He was, however, inclined to believe them to have been built up by a variety of causes, in part by the growth of a reef seawards on a platform formed by pieces of coral that have broken off and rolled down the outer slope of the reef, in part, perhaps, by subsidence, and in part by accretion from the carcasses of the invertebrates living upon their surface.

To examine these cliffs properly one must be lowered over their edge with a rope, or climb their faces by means of the long hanging roots of banyan trees. So Agassiz concluded that the examination had best be made by a younger man who would devote considerable time to it. In pursuance of the advice of Professor T. W. E. David, of the University of Sydney, Mr. E. C. Andrews was selected for this investigation. Mr. Andrews chartered a small cutter, and spent some time among the islands. From his examination it would appear that these "raised reefs" have seldom more than a comparatively moderate thickness, forming a capping that lies outside and over a bedded cream-colored limestone, quite distinct from the so-called reef rock. In some cases Mr. Andrews was able to trace the underlying volcanic formation whose upheaval caused the elevation of the islands. The examination by R. L. Sherlock and E. W. Skeats of the material blasted from the face of the cliff would seem to confirm Agassiz's opinion of the age of these elevated "reefs."

Any one who has followed Agassiz's theory of the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

formation of the atolls and reefs of Fiji will readily understand that whatever the age or formation of these elevated limestones, he considered the method of their origin was quite a separate question from that of modern atolls. For these older limestones have formed the material out of which the atolls have been eroded and denuded, and on whose submarine platforms modern corals have found a footing, just as a cathedral, built over the remains of an ancient temple, would have an entirely different history and structure from the ruin on which it rested.

At whatever time the Fijian upheaval took place, Agassiz thought it was possibly coincident with the elevation of Northern Queensland, and that the area of elevation included New Guinea, and the islands east of it as far south as New Caledonia, and as far east as the most distant of the Paumotus, and extended northward to include the Gilbert, Ellice, Marshall, and Caroline Islands. Since this epoch of elevation the islands within this area have been, like Northern Australia, subject to extensive denudation and erosion.

While Agassiz was preparing for his expedition to Fiji, Professor David was continuing the boring operations on the atoll of Funafuti in the Ellice group, originally undertaken by Professor Sollas, under the auspices of the Royal Society. The day before leaving Cambridge, Agassiz received word that Professor David had succeeded in boring to a depth of nearly six hundred feet and that he was still boring in coral. This seemed to settle the matter, but subsequent letters from Professor David showed that the question was not so simple. Agassiz's investigations in the Fijis convinced him that the boring at Funafuti had settled nothing, "*and that*

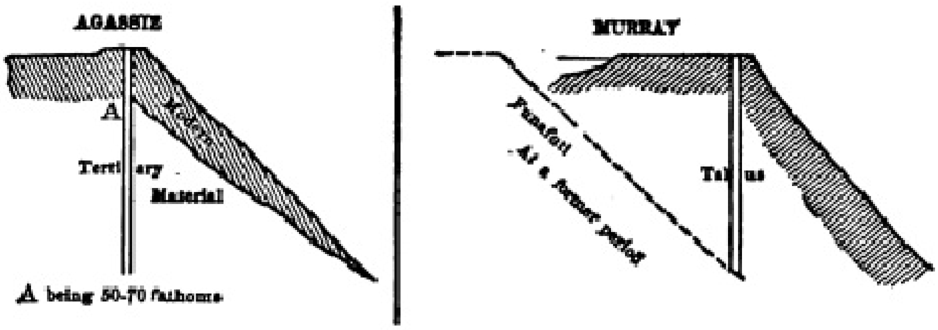
Digitized by Google Original from UNIVERSITY OF MICHIGAN

we are still as far as ever from having a general theory of the formation of coral reefs."

The Funafuti boring was continued the following year to a depth of 1114 feet, when the work was stopped, as the party had exhausted their supply of diamonds. Murray, from his examination of the bore, believes that the drill "passed through a portion of the talus produced by the fragments torn from the growing face of the reef, and on which it had proceeded seawards."

Agassiz, on the other hand, in a letter to Murray in 1907, says of the Funafuti bore: "All I have seen inclines me to think that the core has in part passed through Tertiary limestones, and in part a talus of modern material."

FUNAFUTI[1]



In another letter to Murray, written after the publication of the Funafuti Report, he says: —

"I have been looking over again the Funafuti book. I do not see that the examination of the corals found has been a comparative one and a direct one with recent corals, and I defy any one to make such a comparison

[1] There is, in the coral room at the Museum in Cambridge, a beautiful model of Funafuti, made by Mr. G. C. Curtis, from data supplied by the Royal Society Report, and Agassiz's notes.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

with anything after the great alteration that has taken place in depth by calcite. The mere statement that the corals are identical goes for nothing. If, as I think, the underlying limestone beds of the modern reef are of Tertiary age, as in Fiji and Christmas Island, the difficulty of separating the modern corals and the Tertiary ones is very great and difficult even where these rocks are accessible. I don't think the line of demarcation can be determined by a core where it is drawn between formations with fossils so closely allied to the recent types. The boring should be done in a region where volcanic beds are underlying the coral reefs."

Digitized by Google Original from UNIVERSITY OF MICHIGAN

CHAPTER XVI

1898–1900

THE TROPICAL PACIFIC

The following letter tells something of Agassiz's activities at Newport the summer after his return from the Fijis, when, hoping to devote more time to his research, he resigned the direction of the Museum: —

TO ERNST EHLERS

NEWPORT, Sept. 15, 1898.

I think I can see your hand in the very flattering notice that I have been elected a foreign member of the Göttingen Academy. While I have given up the administration of the Museum, I have naturally retained the care of the publications connected with the expeditions of the Blake, Albatross, and other expeditions which I may have undertaken, or am likely to make hereafter. I already find considerable relief from executive work, and before I go off this winter I hope to be entirely free. Woodworth, who is to be Assistant in charge, will not take hold until beginning of next year, as he goes to Samoa to finish collecting "Bololo" for his paper. When we saw them in Fiji you naturally came to my mind, and I could imagine how greatly you would have enjoyed the sight of the "vermicelli soup." One of my assistants, Dr. Mayer, and I are collecting material for a Revision of the Acalephs of the East Coast, and we have some fine material which will make a new thing

Digitized by Google Original from UNIVERSITY OF MICHIGAN

of my old Catalogue published in '65, and will, I hope, do something to clear up the confusion now existing in the classification of the groups. In the mean time I am at work on the Echini of the Albatross, and Westergren is making some beautiful plates for me. My Report on the Fiji coral reefs is done and only awaiting the completion of the illustrations to go to the printers. I think that Darwin's theory is now disposed of, still I shall not make a general résumé until I have seen the Paumotus, Marshall, Gilbert, and coral reefs of the Indian Ocean. I am now making preparations to go to the Paumotus next August, and see for myself what the reefs there look like. So you see I have laid out for myself quite a little block of work, and I only wish I had made up my mind to give up the Museum ten years ago, as I ought to have done, and have had ten years of younger blood for the coral reefs.

In the winter of 1898–99, Agassiz went to South Africa to see the great gold and diamond mines of the Rand and Kimberley. It was the year before the Boer War, and he was much impressed by the rumblings of preparation which were audible to all except the deaf in office at London. Letters from his English friends opened all doors to him, and his prestige as the president of a great American mine made him a welcome guest of the superintendents and officials of the mining firms of England. When not busy underground or inspecting surface plants, he appears to have been fairly overwhelmed with lunches and dinners.

There were at that time many American mining engineers in South Africa, mostly Californians, some of whom he had known in California in earlier days. At

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Kimberley he was most interested in the ingenious skip and bin for rapid hoisting, devised by Mr. Williams, in charge of the great diamond mine there. This process was afterwards successfully applied in several of the copper mines in northern Michigan; and Agassiz's letter files show that suggestions of his own have since been used with success in the African mines.

Owing to the community of ownership of most of the mines, nothing is projected or carried out without being discussed fully by all the managers; a custom resulting in a unity of action which Agassiz found a great contrast to the constant haggling among the superintendents of some of the small Lake Superior mines. At one of these meetings he was amused to find that the managers were discussing the possibility of mining and hoisting from a greater depth than three thousand feet vertical. At last, when he was asked for his opinion on the subject, he told them, much to their amazement, that at Calumet they had already reached a depth of five thousand feet vertical!

In walking about underground Agassiz unluckily wrenched his knee and brought on a trouble which, from time to time, greatly bothered him for the rest of his life. It is believed that he thought these attacks were gout. They were, however, due to his defective circulation, which showed itself in this weak spot whenever he got out of condition, and set up a dangerous and painful swelling that greatly alarmed his family.

Ever since his return from the Fijis, Agassiz had been planning for an extended voyage through the islands of the South Seas, to include practically all the coral reef regions of the Pacific which he had not yet visited. On his return from South Africa he found that the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Hon. G. M. Bowers, United States Fish Commissioner, had definitely arranged to place the Albatross at his disposal for this expedition. Agassiz was to have the ship under the same conditions as in 1891: he was to pay for the coal, for fitting her out, and certain of the running expenses. Preparations, already under way, were at once completed for sending coal to various points along the route; to the Marquesas by the sailing packets that then plied between San Francisco and Tahiti; and by a special steamer from Australia to Tahiti, to some point in the Paumotus, to Suva, and to Jaliut in the Marshall Islands.

Agassiz again took with him the same assistants he had on his two previous expeditions, besides whom Dr. C. H. Townsend, Mr. A. B. Alexander, and Dr. H. F. Moore were detailed from the Fish Commission.

The Albatross, under Commander J. F. Moser, U.S.N., Lieutenant Hugh Rodman, executive officer, was waiting in San Francisco. Agassiz boarded her there late in August, 1899, for what was to be the longest of his expeditions. A full description of this exploration would require a volume; a glance at Chart 2 will show the track of the Albatross through the following groups of islands: — Marquesas, Paumotus, Society, Cook, Tonga, Fiji, Ellice, Gilbert, Marshall, and Caroline. On leaving the Carolines, the Albatross touched at Guam and then proceeded north to Yokohama, where she arrived on March 4, 1900; here Agassiz left the ship.

The Albatross, unfortunately, proved to be a very different boat from what she was in 1891. Her equipment had been allowed to run down, and her boilers were in such bad condition that she barely crawled against a head wind. So in order to keep the time of the voyage

Digitized by Google Original from UNIVERSITY OF MICHIGAN

within reasonable limits, Agassiz was forced to devote himself almost entirely to its main object, the examination of coral islands, greatly to curtail the pelagic towing, and to abandon most of the dredging.

Nearly all naturalists who have worked with government vessels have suffered from red tape and prejudice, an annoyance so well described by Huxley in the few published fragments of his journal of the voyage of the Rattlesnake. Agassiz seems on this expedition to have chafed more from such vexations than on any other occasion.

"I continue to be more and more disgusted," he says, "at the navy red tape; it is so idiotic on a trip like this to attempt to put on man-of-war style. The natural result is that by the time an order gets carried out it has either lost its value, or might as well not have been given! The other day the chief officer was coming back in a sail boat, and it took fully ten minutes before the officer of the deck, who was below, got it into his head that anybody was waiting for him to give the quartermaster the order to heave a line and keep the boat from drifting to sea again. Yet there was the Captain, the crew, and the officers all looking on and seeing the boat fall off. I could not stand it and chucked him a line, but it seems it was a gross piece of violation of etiquette. I am sure that in a pinch a man would drown before the right person got the order to save him! When I am off in a boat with the younger officers, I always assume that they know nothing about a boat, and they don't, and we get on famously."

On board the Albatross, August 30, 1899: "One week to-night since we left Sausalito. We are just about

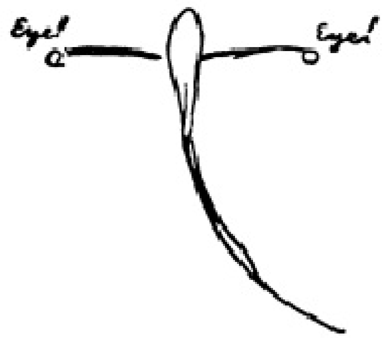
Digitized by Google Original from UNIVERSITY OF MICHIGAN

one-third of the way to the Marquesas, just inside the tropics, on the way for a small island the position of which is quite doubtful on the charts, and in fact we shall probably find that it does not exist at all. The first two days out of San Francisco we did not attempt any work. We were getting ready, and besides we were in ground which had been sounded and which was near enough San Francisco to be worked from there later very conveniently. On the third day we put in our first sounding in a little over 1900 fathoms and lost our thermometer and collecting cup. . . . But what was still worse we smashed our sounding reel from the great pressure that it is subject to in winding the wire; it collapsed entirely when we had wound up about 1700 fathoms; on examining it we found the casting was very defective, of poor quality of steel. . . . But what was our dismay on examining the spare cast steel reel to find it no better quality than the first, and sure enough the next day on making a sounding in 2350 fathoms that went all to pieces, and leaves us with only two old-fashioned reels on which we wound the sounding wire from the broken reels and have fortunately had no mishap, and I hope we shall not have any more breakages on that score, for if we do we might as well have chartered a small boat and gone to work independently of the Albatross, as in the islands she will be no better than any boat of mine.

The weather has been fine so far; neither Max nor I have been seasick, though since we struck the trades the sea has run high, but we are going with it. It is, however, too rough to trawl at such deep water as we get at twenty-five hundred fathoms, so that we only tow down to five to six hundred fathoms and sound, and

Digitized by Google Original from UNIVERSITY OF MICHIGAN

that gives us quite a lot to do. We have found at one hundred fathoms pelagic — a very queer fish with eyes at the end of broom handles! I had never seen anything like it. [Dr.] Chun in the Valdivia got it also, and he says it's characteristic of *very deep water!* and that they get it in their tow nets by sending them way down. The only haul we have made thus far in 2368 fathoms we came upon bottom made up upon manganese nodules, and brought up a lot of sharks' teeth and whales' ear-bones, hauls the like of which the Challenger made at two or three localities in South Pacific and which Murray called my attention to especially! We got half a ton of these nodules, and from the character of the bottom sample I fancy the whole bed of this part of the Pacific is like that where we trawled. We shall see, I hope soon, at least that is my idea of the nature of the sea bottom in the open Pacific way off from land and in the region of prevailing winds where there are but few pelagic animals to drop upon the bottom. I fancy it must be quite different in the region of calms and I hope to settle this in a few days. . . ."



September 5. "We are now just on the edge of the Great Equatorial current and to-morrow I expect to begin towing and trawling in it. To-day we had in sounding in nearly 2900 fathoms the first sample of Radiolarian ooze bottom I have ever seen, and the Salpæ we got at 150 fathoms in tow net were filled with specimens of Radiolarians identical with those we got at the bottom (dead) and which my friend Haeckel says live on the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

bottom! Since I wrote we have been sounding in pretty deep water, nothing less than 2400 fathoms, and one sounding 3088 fathoms. Our bad luck with the sounding apparatus is continuing, and we are not having a single cast such as it should be in all respects — this is bad, and every day gets us further from the true oceanic conditions and little by little we are sure to feel the influence of the plateau on which the Marquesas stand. Still we have left a few days in which to make up — if we lose them we shall have miscarried one very interesting part of our work, all the deep sea oceanic (basin) far from continents which might influence the bottom. We are now just about twelve to fifteen hundred miles from any land! ideal conditions for what I wanted to do, but thanks to the shiftlessness [of the Fish Commission] in not testing their apparatus, it looks as if this my last long expedition was going to be as much of a fizzle as my Australian trip! Not a pleasant prospect, but of course the coral part still remains and the line from Tahiti to Tonga, which is a good line but not an oceanic line like the one San Francisco to Marquesas. . . ."

Albatross — Marquesas, September 15, Taiohae Bay. "Since I have written we have done quite a lot of work and have made some interesting soundings developing the plateau upon which the Marquesas unite at about eight to nine hundred fathoms. One or two of our deep hauls brought up some fine things, but outside the Great Equatorial current there seems to be but little on the bottom. The deep tow-net hauls have been interesting, and we are gradually bringing up a lot of deep-sea types of fishes and of Crustacea which live within a very moderate depth from the surface. A great deal of the value of our soundings is lost from the fact that there

Digitized by Google Original from UNIVERSITY OF MICHIGAN

are no temperatures connected with them, for thus far only one of the deep-sea thermometers on board has been of any use. My only salvation is to drop all that work and make up in work and soundings in atoll groups where, of course, I have the whip handle.

It is very pleasant to be quiet again after such a long trip without seeing a sail or an island. Since my passage from Europe to United States when I was a small boy, I have never taken such a long dose at one time — 22¾ days since leaving San Francisco. As soon as we approached the anchorage the Captain of the Port came up to call and place himself at our disposal. He is the chief of the local police also. Then came the Vice-Administrator who is in charge here, his chief having been called to Papeete. They had not yet got official notice of our being expected, but I read him the letter of the French Minister of Foreign Affairs, and that quite settled it. The Administrator quite remembered George's [his son] being here! It seems he spent a month in the islands and went about a good deal. To-morrow we begin to coal.

To-day everybody is on shore collecting and paying calls and getting information. The native house is very different from anything we have seen at Fiji, built upon a paved platform of huge stones. The natives are fine-looking, remind me more of the Hawaiians than of the Polynesians. But they are beautifully tattooed — unfortunately the tattooing being blue will not photograph. We went to-day to see the old Queen, the wife of a celebrated chief, Toana (who conquered all the Marquesas); she must be eighty years old. She is nearly blind, and in charge of a native woman who looks after her. She still has a splendid crop of hair and good teeth! It

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

is said that not liking her first husband she ate him and married the great chief. Would it not be a good recipe for Newport Divorcées? It would lessen the later scandal so greatly and simplify matters. Of course the husband might be allowed the same privilege! The hands of the old Queen are most beautifully tattooed, and they say she had the most beautifully cut legs in the way of tattoo in existence in her youth, and the Captain Commanding has been trying hard to make her show her feet and ankles; but she would not understand, though we could see her toes were well carved. The natives here are going fast, dying off mainly by consumption; the adjacent valley,[1] which held once three thousand warriors, has now fourteen inhabitants. It seems too bad. Christianity is fatal to the South Sea Islanders — they cannot stand its restraints, and they die like sheep."

Rangiroa, September 22. "Here I am *in* my first Paumotus atoll. Before we left Taiohae, the evening before we sailed, the Acting Governor of the Marquesas gave us quite a dinner which I thought would never end; courses after courses followed one another served by Marquesan servants who really acquitted themselves well of their task. He wound up the performances by giving us a most interesting native dance performed by Marquesans of an adjoining valley. The whole took place on a flat lawn outside the Governor's house, illuminated by kerosene lanterns and huge torches of bagging soaked in kerosene and kept full of kerosene, which lighted up the whole space around the dancers. All Taiohae was there in their best clothes, men, women, and children, and while we were at dinner Woodworth entertained the crowd by giving them selections from

[1] The "Typee" of Melville.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

the phonograph, and you should have seen the astonishment of the crowd — it was comical to see their amazement.

The following morning, while we were waiting for beef and provisions to come on board before weighing anchor, the whole lot of dancers came on board to see the ship. We showed them round the ship, cabin and ward room. They were most happy, — the mirrors, electric lights and fans and the machinery and propeller, which they had learned to know from looking at the steam launch when she was going to and from the shore. They wound up by giving us a dance and a song, such as they had given us the day before. The song is quite melancholy, very different from the usual Pacific melodies I have heard before, and always ends rather abruptly, much like the last sounding note of an organ; then we weighed anchor and off they set for shore, giving us a hurrah in reply to our steam whistles.

Two days ago we struck the islands of Manihi and Ahe. As it did not look very profitable to tackle them, we made for this place, Rangiroa, one of the largest, if not the largest atoll of the group, forty-five miles by sixteen! We lay off the entrance called Avatoru Pass for an hour or so early day before yesterday, where the chief and two men came out in a small boat and told us we were all right, and in we steamed with their sanction through a narrow pass, out of which the current was rushing at the rate of four to five knots an hour, and got safely to anchor a little way inside of a most uninteresting village consisting principally of broken-down European houses inhabited by natives, who since they have become Christians live like very low-down Christians. The men are a fine lot, tall, intelligent, living on

Digitized by Google Original from UNIVERSITY OF MICHIGAN

what they make by selling copra of which at one time they exported a thousand tons a year, quite a profit for the couple of hundred inhabitants of the place, but of late the palm trees have not done so well and the natives have had a hard time. Fortunately there are no end of fish here, and they get plenty to eat.

The French flag was floating over "the Palace" of the Gendarmerie, occupied as we found by a single brigadier who has lived here five years and seems perfectly satisfied with his lot and says so! Yet he appears like quite an intelligent person; he is the only white man of the place, and has no one to spend his time with. As usual he has a native wife, and that 's a bad chain for a man to have round his neck here. If there are children, it means he must end his days here in the South Pacific.

Yesterday and to-day I have been spending my time examining this atoll, so different from any I had ever seen, but still a fine specimen of the kind which had always been thrown at me; and though I have not yet got through with this one, yet it looks as if I now would have the chance to throw this kind of atoll at the other side. I am beginning to see daylight, and hope to get a sketch outline of the atoll to-morrow, which will make everything very simple, to *me* at least. We have been taking no end of photographs at this place, for being my first shot I am bound to illustrate it fully. You will find on the chart of the Paumotus a sketch of this atoll which looks like a pear and is about sixteen fathoms deep, full of rocks at the handle end. With the exception of a few scrub trees there are only bushes and palm trees and no water except what soaks through the soil — that is very little. If the rest of the group is as plain sailing a thing as this atoll, it will not be a

Digitized by Google Original from UNIVERSITY OF MICHIGAN

long job to finish up, so that when there are two atolls close together I can send a party to photograph and take the adjoining atoll.

The tail end of this [part of the] trip is making up



for many disappointments on the way, and all told when I look back I ought to be satisfied with what I've accomplished."

Off Rangiroa, September 24. "Yesterday we took a trip in the launch from Avatoru Pass straight across the lagoon to the point B., about thirteen miles. This same line the Executive Officer sounded out for me, so that as to-day we are running a line of soundings out to sea off the Avatoru Pass and are going to do the same thing off the south side, it will give a magnificent section across an atoll, and the rough plotting I have made of the figures brings out an outline—as it should—much like the elevated islands of which I have photographs in Fiji. Yesterday when we started we found, as usual, that the Herreshoff launch was not in shape, and we had to tinker for almost an hour before we could start; and I must say that during the whole trip the Captain and I were somewhat nervous as to how long she would run, but we managed to get through all right.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

We towed a dingey behind and took a native pilot with us, the same who piloted us in, and who landed us on the other side in the neatest little boat harbor imaginable. On our way we passed an interesting little island composed of elevated limestone (as it should be if my ideas are correct), and when about two miles off, the bare reef about twelve to fourteen feet high, which connects the island and islets, began to loom up and was soon in full view.

As soon as we landed we began to take photographs. I rushed across the islet to examine the limestone ridge which flanks the islets on the sea face, and which Dana saw from *shipboard* and described as elevated recent reef! I was tickled to death when I got there to find myself on familiar ground. I could imagine myself at one of the elevated Fiji atolls like Ngele Levu, where the land is, however, seventy-five feet high and only fourteen in this place; but it is the same pitted, honeycombed, eroded rock with which I had become familiar in Fiji, and full of the same magnificent coral rock fossils which it would take an age to collect by blasting out, but I managed to chip off a few characteristic fragments. I think I have the key of the Paumotu coral reef problem, and it 's only an expansion of what I have seen in Fiji; only this group is comparatively plain sailing and clear work, for Dana did not examine his islands very closely; as, for instance, the greatest detail he gives of an island of the Paumotu group is from what he saw sailing by! As for Darwin, he only sailed through and never stopped at all, so that I am quite sure that unless something new and unforeseen turns up, I can chuck this group of atolls at the heads of the Darwin-Dana party and ask them for the next!"

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Off Tahiti, September 27. "After leaving Rangiroa we steamed west round the two adjacent atolls; these appeared to show nothing special or different from the one we examined and fall into the line well. . . . After leaving Matahiva we ran a line of soundings to Aurora Island, which is a fine specimen of an elevated island such as we had in Fiji, only finer perhaps. . . . I got the whaleboat and the dory, and in less than an hour we were all ashore collecting and taking photographs. The surf was no worse than it is on ordinary days on Collins Beach,[1] and you would have thought we were trying to land in a hurricane! All we got were wet feet, and we got off perfectly well with all our collections and photographs dry as chips. What we saw was just as at Fiji, and now I feel that my views of the Paumotus are settled. It 's merely a question of reconnoitering a dozen or more islands, and I hope we may get through this in a month after we coal instead of six weeks or so, as I had laid out. From here, Aurora Island, we shall run a line of soundings to Tahiti where will end the first part of our trip, and on whole very successful but could have been better."

After coaling at Papeete, the Albatross again made for the Paumotus, calling on the way at the little islands of Tetiaroa, about thirty miles to the northeast of Papeete, which Agassiz was delighted to find composed of limestone, as this fitted them nicely into his scheme of coral reefs.

Fakarava, October 11. "We have been most successful thus far. After leaving Makatea we went to Niau, which was another island (elevated) according to

[1] Now Bateman's Beach, Newport.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

my ideas. This island has a sink as lagoon not more than twelve feet deep with mullet and a few sea-shells, but no corals, and is just such a lagoon as I wanted to prove how the Paumotu Lagoons have been made; and at a little island (to the northeast) called Tikei, I found a still smaller sink — just what might be expected of so small a place. We stopped at the entrance of Apataki, quite a large lagoon, just like the other lagoons we have seen. In fact it now looks to me as if I had a sample of all the kinds of atolls to be got in this archipelago. For the past three days, since we left Apataki it has been blowing very hard, so that our passages have been very uncomfortable, just like the trade winds in the Caribbean — in fact a little worse. But this kind of weather (as usual) is not expected and the natives don't know what to make of it. But it's no consolation to us, for with such a wind there is no exploring to be made by water in the lagoon, and we are helpless until the weather changes and the sea goes down. This lagoon is fully twenty miles long and ten wide, not so large as Rangiroa, nor so populous."

While stormbound he writes Mrs. Agassiz: —

"This is one of the islands where Stevenson exiled himself for a few months. The more I see and read of what Stevenson did in the Pacific, the more inclined I am to look upon him as a ———. Certainly all he writes may be good English, but it has neither common sense nor accurate observation; perhaps he did not fancy that any one would walk in his tracks so soon. What there is here to attract one I cannot see, unless it be a cure for nervous prostration — it's sure to kill that here! When it comes to seeing such noble qualities in

Digitized by Google Original from UNIVERSITY OF MICHIGAN

the natives of a place like this, I should say, Bosh! That kind of talk always reminds me of commentaries on Latin and Greek classics, written in the glare of electric lights and other modern accompaniments."

On board the Albatross, off Tahanea, October 16, 1899. "The bad weather did not last very long at Fakarava and we were able to put in two excellent days in and on the lagoon. I had a fine chance to look at the greater part of the island under the lee of which we were anchored, both on the lagoon and on the sea face. The sea face was wonderfully rich in invertebrates, so we made a fine collection of shore things, some of them very interesting, in addition to studying the conditions of the shore for the coral reef problem.

To-day when off Tahanea we had a most interesting time. This lagoon presents features quite different from other lagoons. I never have read of any such structures as I have seen; we made no end of photographs, backing and filling to get good views so that Mayer and Woodworth were kept going at a canter. We must have so far at least two hundred views from which to select, and my notes are being filled out fast. If we could have had only a good survey of these islands, how much simpler it would have been to explain matters."

Makemo, October 20. "We arrived here yesterday noon, and are here awaiting the Southern Cross with our coal. She was to be here yesterday or to-day, but thus far no signs of her. Since leaving Fakarava we have had most interesting visits to the atolls on the northeast side of Paumotu: Takume, and Raroia, which are slightly different from the others. The weather has continued superb until last night when it has set in

Digitized by Google Original from UNIVERSITY OF MICHIGAN

regular hard trade and will, I presume, continue so now for three or four days, when there will be a chance to slip out again after coaling and do some work. Day before yesterday we steamed all round Takume (or Wolkonsky, as map has it); it was as smooth as glass, and we had an excellent opportunity to see the whole place, for though the lagoon is sixteen miles long it has only a breadth of two to two and a half anywhere and very sharp points. This gave us a lot of good photographs showing the two sides at once. . . . We have made quite a number of soundings between the islands, which go to show that those atolls are not so immensely steep but rise from a great plateau. I am gradually knocking out a lot of superstitions about atolls, and it is really absurd that Darwin and Dana should have written such a lot of nonsense, all evolved from their own brains or reading of what others have said and done. . . .

I am gradually getting the formation of these lagoons into my head, and am not at all surprised that with the limited experience of Dana he should have seen things all twisted round as he describes them."

After exploring the Paumotus, the Albatross again touched at Papeete before visiting the other Society Islands.

Anchorage, Hurepiti Bay, Tahaa, Society Islands, November 16. "You can't imagine what a beautiful little bay we are at anchor in — a deep bight with high hills on each side looking out through the Barrier Reef. The sea has all day been as smooth as a mirror and now there is not the least breath. The moon has risen and the scene is perfect. . . .

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Murea, the nearest of the Society Islands to Papeete, is the most picturesque of all. Unfortunately, what with our breakdown and rain squalls, we could get no photos of it. . . . Huaheine, Raiatea, and Tahaa are beautiful places and their barrier reefs are superb, taking on a development compared to which the Fiji reefs are as nothing. The islands are as a whole (except the two large Fiji ones) much larger, yet not so large as to lose the unity — and that makes them so interesting. They are thickly populated — the shore lines are edged with houses all on piles and quite different from any style of house we have seen in the islands thus far. Bora Bora is a most striking island. The centre of the lagoon of the island is occupied by a great twin peak rising fully three thousand feet above the sea level and the barrier reef is edged with little islets covered with cocoanut trees in great contrast to the bare volcanic sides of the central mass."

Touching at the Cook group, the ship on November 25 made an isolated island about three hundred miles northeast of Tonga, called Niue or Savage Island, because in old days the natives murdered any one who dared land on its shores. Although the inhabitants are still independent, having a so-called king elected by the chiefs of the various villages, the spirit of "civilization" has invaded the island. For when a landing party from the Albatross reached the shore the natives rushed toward them shouting, "Give tabac," and thrusting their hands into the visitors' pockets demanded, "Mun! Mun!!"

They were all supposed to be Christians, over whom the missionary held despotic sway. Agassiz had an amusing adventure with him. It was Sunday on the island,

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

so no one was allowed to trade with the ship, which was sadly in need of fresh provisions. Now the Albatross, coming from the east, had not yet dropped a day, and it was Saturday on board. Going to the missionary, Agassiz told him that unless he allowed the natives to sell to the ship, he would explain to them that Sunday was such an artificial thing that for two white men coming from different quarters of the earth it existed on different days. After a little reflection the Rev. Mr. L—— removed the tabu.

Agassiz had but little sympathy for what he saw of missionary life, of which he writes: —

"What I never like in the South Pacific is to see the swell houses (comparatively speaking) of the missionaries. They always in all the islands have the very best of everything, and certainly don't show the natives any example of plain living, for they are most comfortable and have no end of servants. . . . I have been reading M——n, and such twaddle passes my comprehension. It is nothing but an apology to join the European band of robbers in despoiling the barbarians, as we are pleased to call them, and compelling them to buy our goods and wares in addition to stealing their land — all in the name of spreading civilization! Just as the missionary swindles in the South Seas, who trades with natives, makes a lot of rules for them adapted to our uses, and compels them to do as we think right, all in the name of Christianity! — and if they resist the missionary claims the protection of a Man-of-War of his Country! What fun it would be for a man of energy and pluck to come among the islanders and help them to resist such aggressions. . . ."

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

As the Albatross approached the deep hole, about 75 miles from Tongatabu, preparations were made with care and considerable anxiety for what was by far the deepest dredging ever accomplished; and the trawl was finally lowered in 4173 fathoms. When at last the net was successfully hauled on board there was naturally much curiosity to see what it contained. The first thing to fall out was a small rubber frog. Agassiz looked at it for a second in amazement, and then, glancing up with a smile, exclaimed, "That d—— Rodman!" Much to his surprise, as he had expected nothing but mud, the bag contained a number of large fragments of a silicious sponge, and the bottom was found to consist of light-brown volcanic mud mixed with radiolarians.

When the Albatross was sighted approaching the harbor of Nukualofa on Tongatabu, the king of the islands called for his army of thirty-five men, who had been peacefully digging yams, forced them into the most uncomfortable European uniforms, and kept them occupied firing a brass cannon by way of salute.

"We went to see his Majesty King George of Tonga, with the British Consul. It was quite an *opéra bouffe* performance and reminded me of old times at Honolulu with old King Kalakaua. The King was got up in his uniform with stars and orders, and sat in a high chair with a crown on the back of it. His cabinet surrounded him and one of the missionaries acted as interpreter. The Captain and a few officers were in their full toggings, and Woodworth and I in white clothes. The palace is a cheap tawdry American wooden house with gaudy carpets. We were received at the gate by the King! band playing 'Hail Columbia,' and the King's army of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

thirty-five men who presented arms as we passed in the Palace yard. We sat and talked back and forth for an hour or so and then took our leave, asking the King if he wanted to come on board and see the equipment of the Albatross."

After a reconnaissance of the Tonga group the Albatross was headed for the southeastern edge of the Fijis.

"We left Vavau day before yesterday afternoon with a spanking trade and all sails set, going altogether too fast, so we had to slow up and lay to for a part of the night so as to make Yangasá early this A.M., and sure enough the first island I saw looking out of my port was Yangasá, which is most peculiar in outline and the like of which there is not in the southern part of Fiji. On going to the Pilot House I told the Captain what it was, and he with great glee told me I was quite mistaken and that it was another island to the south. I didn't stop to argue, and after half an hour's monkeying with the chart to make it suit his views I noticed he changed his course and said nothing! He then confronted me with the sailing directions to show he was right, and I confronted him with a photograph, which settled the matter."

Agassiz stopped at Kambara, which he had visited in 1897, in order once more to examine its cup-like summit, so characteristic of the limestone islands of Fiji.

"It was very funny to see how pleased the natives were to see us again. The old chief and his wife greeted us

Digitized by Google Original from UNIVERSITY OF MICHIGAN

in a most stately manner, and after our return from the hill we called to bid him good-bye, and the Captain and I wandered round to the huts and the houses to see what they had. The officers got a lot of Kava bowls — this is a great place for them and for building canoes, the island being full of very large hard-wood trees. One of the women we saw was really quite a type. She must have been, from her frowsy look, the pattern after which the native woman of the Fiji Group was depicted! She had red hair like a sheep's-wool mat standing out at right angles to her head, an arm big enough to kill an ox if she struck him, and a sort of wild look in her face. The chief's wife came on board with us, and kept watch of the whole crowd, and took the whole party on shore again after they had given us one of their songs on deck. It is really refreshing to get to a village again where nobody can speak English, and where there are no missionaries or traders and the natives run themselves. A cleaner and more attractive village we had not seen."

Passing his old anchorage, the crater harbor of Totoya, Agassiz reached Suva on December 11, 1899. "You have no idea how much at home I feel here," he writes. "It 's really like getting halfway to Cambridge when coming back from the mine! Everybody from the Governor down most attentive and I feel as if I owned the islands. . . ."

The Albatross remained a few days in Suva to coal and provision, and then started for the Ellice Islands. Here Agassiz writes from the island celebrated as the site of the boring of the Royal Society.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

ALBATROSS, FUNAFUTI, Dec. 25th, 1899.

"Little did I expect when leaving Fiji two years ago, to be spending Xmas at anchor in this atoll. We left Suva the 19th and steamed among our old island friends, and the following morning were bidding farewell to the last outlying reefs and islands, and Ngele Levu was the end of all Fiji Islands. Ever since leaving Suva the weather has been superb, getting gradually hotter and to-day is the warmest day we have had. The water in the atoll is 89 and the air is about 104 — and as it's pretty moist atmosphere, it is warm enough even for me.

I found Funafuti just as different from other atolls as possible, and I have been here for three days mousing round and getting the hang of the schoolhouse. I have now got hold of the structure of the place and understand it, and as far as I go it's all on my side. But I begin to see how useless it is to discuss coral islands between people who have not seen the same thing. I could not make out what David, Sollas, and Gardiner meant until I had seen Funafuti — it's so different from all other atolls, and unless I had my experience to go upon it would be hopeless for me to give a natural explanation, and I should be groping round and talking in the air. It was very funny going round the shores to find the tracks of the David and Sollas party where they had broken off samples of the reef ledges! two years ago. I go off at six A.M., get back at eleven, and off again at four till night. . . .

The people here are very primitive, wearing grass skirts, and their houses very different from any we have seen, all open except mats which they drop like rattan mats against rain or sun. They raise a floor, upon which they sleep, about two feet. They live on chicken, pigs,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

eggs, bananas, and cocoanuts, and go fishing, and their canoes are very primitive. The population seems absolutely in the hands of native missionaries of the London Society, which rule them with a rod of iron, fine them on all possible occasions. Why they stand it I can't see — compel them to wear clothes from which they get skin diseases, consumption, and children all dying! Yesterday was Sunday, and women all came out in mother hubbards and bonnets and hats!! You never saw such guys and they went to church five times! To-day they have again cast off their fine clothes and gone back to a more scanty rig.

It 's a pity there can't be a little common sense infused into this religious cant. As it is now, it 's sheer cruelty and enforcing of arbitrary rules against health and decency as the people understand it. There are three Catholic priests here who are trying to make converts by bribing them with tobacco, the other sects just now being out of that article. Do the missionaries really imagine in their heart of hearts that the native can draw the line between Episcopalians, Methodists, Wesleyan, Mormons, and Catholics, etc. It 's really too disgusting, and we go on spending lives and money to save souls, or rather to make Christians of them. I should like nothing better if I had time to enter into a crusade against such barbarism and show up the mission fraud. Well meant, I have no doubt, but — !"

Upon leaving the Ellice group, Agassiz examined the principal atolls of the Gilberts. Dr. Mayer complains that "going ashore in this group was not an unmixed pleasure, for the natives insisted upon opening our jaws in order to admire the gold fillings in our teeth." Here

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Agassiz obtained what was probably the last complete suit of cocoanut fibre armor on the islands. Always on the watch for anything of this character, he writes, "I have got quite a number of mats, axes, weapons, from the different islands which are getting very valuable,[1] as the advent of civilization spoils their habits for this old-fashioned work, and they forget their own arts in the care of buying cotton cloth and all the cheap stuff which they now buy from the traders in exchange for their copra and fruit."

The Albatross reached Jaluit, the capital of the Marshalls, early in January.

TO MISS E. H. CLARK

JALUIT, Jan. 10, 1900.

We had a fair passage from Taritari, but how slow, 240 miles in two days and only delayed three hours by soundings. This is a fair sample of the speed and how it interferes with all work. We ought to have in that time made a passage and spent the greater part of the day trawling, etc., but we should never get anywhere did I do anything but coral work and the necessary soundings.

I have found all the coal I had ordered here and in excellent condition. . . . The Germans here in charge are most pleasant people; the agent for the Jaluit Company, Mr. Hütter, is an educated man who has been in charge of the Marshall Island business since 1885, at the time when the Company which practically owned the islands passed them over to the German Government. We dined with him and the Commissioner in charge of the German Government interests who has a very pleasant

[1] This collection is now at the Peabody Museum in Cambridge.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

wife, an American, who speaks all possible languages. The Doctor of the colony is also an excellent representative, and I could not help contrasting the small number of officials, who run the Marshalls at a profit in true commercial German style, and the pomp of the Fiji with its huge staff eating away all the revenues. . . . But this is terribly isolated — a mail about once in three months and a Man-of-War twice a year — since they have bought the Carolines and Ladrones I fancy they 'll have to do more, as their possessions are now quite well concentrated and extend from New Guinea to Marshall, a pretty well unbroken series of islands. But why they want them I can't imagine — the more of that sort of possessions they have the worse off they will be!

The Albatross spent nearly a month exploring the huge atolls of the group, which are remarkable for the relatively small area of their land rims, when compared with the vastness of the enclosed lagoons. The chiefs still reigned supreme there, and owned all the land, so that the other natives were little better than their slaves. Of the atolls of Menschikov and Rongelab, Agassiz writes: "Neither of these places has many genuine natives left — civilization has crept in too far and galvanized iron has replaced thatched roofs, and clothes, their beautiful mats. At Rongelab we found one of the few native chiefs got up to kill in his grass skirt and bits and necklaces in hair and feather top-knot. Woodworth took his picture and then we bought his whole dress suit for $1.25!!"

"The islands are very fertile, but the natives make little of them, and really live very poorly and have

Digitized by Google Original from UNIVERSITY OF MICHIGAN

nothing in their huts, which are mere sheds on posts to keep the rain out, but they do make beautiful mats and fans and the finest canoes in the Central Pacific. The poor devils are all round the ship to-day sitting in their shirts in their canoes quietly catching the rain and their death-cold, while if they were bare-skinned they would pass scot free. One man specially was a fine specimen of missionary dress; he had on his customary mats, and in addition had put on a long mother hubbard gown in which he looked most comical and might have been exhibited as a bearded woman! and his photograph sent round to all religious papers as one of the finest examples of the success of missionary work in converting a naked savage to a clothed Christian! It's sickening were it not so comical."

Agassiz was always fascinated by the skill with which these natives handled their great outriggered sailing canoes. Unlike the superb men of Tonga and Fiji, the Marshall Islanders are small, thin, and stooping, with sullen, forbidding countenances. They are, nevertheless, the most daring navigators of the South Seas, sailing long distances by the aid of their curious "charts," made of sticks lashed together. A number of these, brought back from the expedition, are now at the Peabody Museum.

After again coaling at Jaluit, the Albatross proceeded westward through the Carolines, touching, among other places, at Kusaie, Ponapi, and the Archipelago of Truk. On leaving Truk the expedition headed northwest, bound for Guam, our new possession. There the Albatross anchored off the old-fashioned stone fort which commands the harbor. At the height of the Spanish

Digitized by Google Original from UNIVERSITY OF MICHIGAN

War, not many months before, the U.S.S. Charleston, so the story goes, appeared from the unknown world and fired upon this bulwark of defense. The Spanish Governor, mistaking the attack for a salute, sent out a boat to apologize for not returning it, as he was out of powder.

"The [present] Governor is Captain ——, of the Navy, who is a half-religious crank and keeps issuing proclamations which I fancy are all illegal, as he undertakes to do a lot of things which Congress has most distinctly forbidden in any part of the United States."

On their arrival in Japan on March 4, 1900, Agassiz and his party were most hospitably entertained by the late Professor Mitsukuri, of the Imperial University of Tokyo, who worked on some of Agassiz's collections. After giving an address at the Japanese Geographical Society, and being the guest of honor at a Japanese dinner at the famous Maple Club in Tokyo, Agassiz sailed for San Francisco, where he arrived early in April.

He was now approaching sixty-five, and the pace was telling. "I am beginning to realize," he writes, "that I am too old to go on such expeditions as this — it 's too hard for me to have such a long pull — a couple of months' work in the field is all I can carry now, and I ought to have started on these expeditions fully ten years ago when I was younger and stronger and had more go to me than I can possibly expect to have hereafter. It 's too late!"

This chapter would be incomplete without a short summary of the conclusions that Agassiz reached, after the tremendous labor of examining the almost endless groups of atolls and islands through which the Albatross threaded her way. In the Paumotus he was able

Digitized by Google Original from UNIVERSITY OF MICHIGAN

to show that the formation of the atolls is due to very much the same causes which have shaped the limestone islands of the Fijis, namely, to elevation and a subsequent eating away of the elevated islands. The fact that the Paumotus are all of nearly the same height he explained by supposing them to have been (before erosion) only slightly and about equally elevated. In most of the atolls of this group the Tertiary limestones have been cut down to the water's edge. The appearance of the old Tertiary ledge and of the modern reef rock is so strikingly different, that it was a comparatively simple matter to distinguish the two, even where only relatively small fragments were found.

Whereas in the Fijis the islands on the atoll rims are the remnants of an elevated island that once covered the entire area of the atoll, in the Paumotus the original islands have been, in most cases, completely cut away, and the land rim has been formed by the refuse of the old ledge, combined with the fragments of the coral that has established itself upon it, which gradually build up small islands on the reef flat; these slowly grow, become fused, and form a more or less connected rim about the lagoon.

The reef shelves of the Paumotus, far wider than those in the Fijis, supply great masses of material from the breaking up of the outer and inner edges of the Tertiary limestone platforms. These, together with the fragments of coral growing upon the flats, are thrown up on the reef flats and form a pudding stone or breccia. This pudding stone or beach rock is found on all the atolls of the group. It forms great bars, generally at right angles to the shore line. The sea and wind usually follow the trend of the shores, and the bars of beach

Digitized by Google Original from UNIVERSITY OF MICHIGAN

rock act like buttresses and collect coral shingle, and thus are built up little by little, at first small sand bars, then larger bars or islets, which gradually form islands. In the larger atolls, with lagoons many miles across, the trade wind creates a very considerable sea inside the lagoon, and the process goes on in the lagoon as well as on the sea side of the reef flat. Gradually the islands become covered with vegetation, and when the refuse material is very abundant, the land rim becomes more or less solid, forming a series of islands with passages between them. The formation of these land rims can be traced from an atoll like Fakarava, where the islands, especially on the lee side, are widely scattered along the rim of the reef; or at Rangiroa, where the islands are rather less scattered, until as the process of filling in of the islands continues, there results such an atoll as Pinaki, with a continuous land rim, and one shallow passage into the lagoon. One step further, and we may imagine this atoll entirely enclosed like Niau (which, however, was never planed down to sea level), when it would be merely a question of time for the sand to blow in and fill the lagoon.

Niau is the only one of the larger atolls of the Paumotus whose lagoon is entirely cut off from the sea; in general, all the atolls are now in a condition which allows a vast amount of water to be forced into the lagoons; this scours them out in the manner described in the preceding chapter. Dana and other writers on coral reefs mention a great number of lagoons as being absolutely shut off from the sea: such descriptions must have been taken from charts, where many atolls are indicated as closed because they have no boat passages. For nothing would be easier than to pass unnoticed, even at a short

Digitized by Google Original from UNIVERSITY OF MICHIGAN

distance, the wide or narrow cuts which allow in many cases the freest access of the sea to the interior of their lagoons.

Pinaki (Whitsunday) is perhaps the most interesting atoll of the group historically. It was discovered by Captain Wallis in 1767; it is about one and a half miles in diameter, is nearly circular, and the continuous land rim has but one narrow entrance, too shallow for rowboats even in a smooth sea. The somewhat diagrammatic sketch of this atoll by Beechey has been so frequently reproduced in text books, that it has come to be looked upon as the typical atoll. While it is undoubtedly an interesting phase in the history of atolls, its constant reproduction has given it a celebrity out of all proportion to its importance, and has gone far to disseminate a very erroneous impression of what an atoll is. In reality, Pinaki, instead of being typical, is quite exceptional.

The larger of the Society Islands are volcanic peaks, surrounded by barrier reefs, which owe their existence to precisely the same process of denudation and erosion that has taken place in the very similar volcanic islands of the Fijis — Kandavu, Mbenga, Nairai, etc. There is one point, however, in which the barrier reefs of the Society Islands and Fiji differ. In the Fijis, the barrier reefs are generally merely reef flats upon which the sea breaks, with an occasional rocky island or negro head; only rarely are sand keys found there. On the more extensive reef flats of the Society Islands, on the contrary, the barrier reefs are well indicated by long lines of narrow islets formed from the débris of the reef platform, débris piled up exactly as the land rims of the atolls of the Paumotus. The peculiar aspect of these well-wooded

Digitized by Google Original from UNIVERSITY OF MICHIGAN

barrier reefs may be seen, at the Cambridge Museum, in the beautiful model of the Island of Bora Bora, by Mr. G. C. Curtis, who was sent by Agassiz to the island, and passed some time there making notes, measurements, drawings, and soundings.

Tetiaroa and Motu Iti, two atolls of the Society group, are from their position probably volcanic, and represent the final denudation of such an island as Bora Bora. The first stage in this process is well exemplified in Maupiti, consisting of a smaller and less lofty central island, and a proportionally more extensive barrier reef flat.

Like the Fijis, the Tonga group is partly volcanic and partly elevated Tertiary coralliferous limestones, here developed on a scale far beyond those of the Fijis. Agassiz was able, from the examination of the Tonga Islands, to satisfy himself that recent corals had played no part in the formation either of the masses of land or the plateau of the Tonga Ridge, where they are a mere thin living shell, or crust, growing at their characteristic depths, upon either limestone or volcanic platforms, the formation of which has been independent of the growth of recent corals.

The existence of the archipelago of Truk in the Carolines, one of the volcanic formations of the group, he was convinced could be accounted for by the same agencies instrumental in creating similar formations in the Fijis. He concluded that some of the atolls in the Carolines had probably volcanic and others limestone foundations, but in none of them did he find the bases exposed.

Nor in the atolls of the Ellice, Gilbert, or Marshall Islands, was Agassiz able to observe the character of the underlying base which forms the foundations of the land areas of these groups. In this respect these archi-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

pelagoes are in striking contrast to the Paumotus, the Society Islands, the Tonga, and the Fiji Islands, where the character of the underlying foundations of the land rims is readily ascertained. But on the other hand, the first groups gave him the means of studying the formation of the land rims in a most satisfactory manner. He was nowhere else able to trace so clearly the results of the various agencies at work in shaping the endless variations produced in the islands and islets of the rims of the different atolls by the incessant handling and rehandling of the material in place, or of the fresh material added from the disintegration of the faces of the rims, or of the corals on the slopes.

In many of these atolls he was also able to observe how the luxuriant growths, on the reef flats, of such corals as Porites, are gradually changed into dead reef flats, with a surface cemented by Nullipores; they thus become the base upon which a land rim of bars or islands is gradually thrown up.

In concluding, Agassiz mentions his opinion that thus far no observer has given sufficient weight to the action of the trade winds in modifying the islands within their limits; or has noticed that the coral-reef areas are, with few exceptions, situated within the limits of the trades, both north and south of the Equator.

In 1839, Wilkes, wishing to give some future voyager an opportunity of measuring the growth of a coral reef, set up a monument at Point Venus on the island of Tahiti. A bench mark showed the height above a certain point on the adjacent Dolphin bank. Agassiz was naturally anxious to avail himself of this chance to measure the growth of coral in sixty years. After all the misinformation that had been published about coral

Digitized by Google Original from UNIVERSITY OF MICHIGAN

reefs, he was not so completely surprised to find that the point selected was not over a bank of growing corals at all, for the bottom was covered with broken fragments of dead coral coated with Nullipores. As he very justly remarks, "a more unfortunate selection could not have been made."

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

CHAPTER XVII

1900–1902

THE MALDIVES

As usual in his later years, Agassiz spent the summer of 1900 at Newport, busy working over the reports of his previous expeditions.

TO ERNST EHLERS

CASTLE HILL, NEWPORT,
Sept. 1, 1900.

I am hard at work on my Report of my last expedition to Pacific, and hope soon to issue a short preliminary Report on the final results of the trip with charts of the route, and next will come I hope my Report on the Coral Reefs of the Pacific, which should be one of my best things, for the amount of material I have collected for that is colossal both in way of photographs and in the way of ground covered by the Albatross. But I fear it will take about two years of the hardest kind of work, and I find I do not work quite so readily now as I did twenty years ago. The side issues of the expedition will take a good deal of time also, but I hope with the help of the collaborators I have to get out the results in due time, and there is still a good deal left of the Blake and of the 1891 Expedition of Albatross, and before all the Reports are out my own share of laying out the results as a whole must remain in abeyance. The Echini of the 1891 Expedition are now well under way

Digitized by Google Original from UNIVERSITY OF MICHIGAN

and this ought to make an interesting Report. I have some thirty Plates of that done and am pushing it fast. Some of the Plates by Westergren are very beautiful, and I really wish I could have got hold of him long ago for my Challenger and Blake Plates. It is a real pleasure to work with such an artist, who knows so much of the subject himself and is perfectly enthusiastic on the subject. I expect next winter to pass a few weeks in London and Paris to look at some Echini, and if I can manage it I shall try and run over and see my German friends.

Agassiz passed the winter of 1900–01 in Europe. Most of his time he spent in Paris, Berlin, Vienna, and Leipzig, examining the collections of the more recent deep-sea expeditions of the Travailleur, Talisman, Valdivia, and Pola. While in Paris, he found time to allow Jules Lefebvre to paint his portrait, for which some of his friends had given a fund to the Harvard Corporation. This picture now hangs in the main entrance hall of the Museum. Agassiz is represented standing, clad in the scarlet robes of a doctor of Cambridge, England. The portrait is academic and stiff, and hardly suggests his character; it is, however, not out of harmony with its surroundings, and is perhaps a more fitting memento than a less formal likeness. Shortly after the picture was hung in its place, an old German retainer of the Museum was seen to pause before it a few moments, and exclaim scornfully as he proceeded on his way: "Hum! — the Professor looks as if he had been speaking French!"

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

TO MRS. LOUIS AGASSIZ

PARIS, March 9, 1901.

Quite a long letter from you to-day and am sorry to see that the summing-up of the winter has been such a long housing for you from cold, etc. My wrist is all right again, but I use it a little carefully, as you will see from my new chirography.

I bought a second Rosa Bonheur to-day, a splendid Royal Tiger — it is really superb. I don't know where I shall put it in Cambridge any more than the Lion. The two will not do in the same room. Each is fine of its kind, and what is good especially is the characteristic landscape. Usually this is anything — in both cases the beasts are in their lair and as they live. Perhaps you know she had lions on her place and used to live at the Jardin des Plantes when she was painting the tiger. I never saw such movement as the beast has — he is superb. Max quite approves of my purchases in way of pictures, and as the boys are to have them they had better be to their taste also.

There are some of the modified impressionist landscape painters here whose things I like very much also, so I indulged in a couple. There was one by Monet I would have bought, but Max could not stand it, though he acknowledged it was the best of its kind he had seen. I dare say Ida would have appreciated it, but Quin feels about them much as I do — he would not give them house room. The only way to have them is about a mile off — then they are superb. They suggest anything and everything you can fancy. It is astonishing what a lot of pictures are sold here to go to America. We seem to be cleaning up the picture market as fast as they are produced.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

On his return to America, Agassiz completed his preparations for an expedition to the Maldives, a curious group of composite atolls which lie about four hundred miles to the southwestward of Ceylon. Previous to his visit, there had been two memorable expeditions to these islands. In 1834–36, Commander Moresby made a survey of most of the group, upon which the Admiralty Charts are based. The accuracy of this work is marvelous when it is remembered that it was done in the days of handlines, row-boats and sailing vessels. The other explorer, Dr. J. Stanley Gardiner, had lately returned from a prolonged study of the group, mostly accomplished in a small sailing boat; but the results of this expedition had not yet been published.

Darwin, who never visited the Maldives, considered their peculiar formation due to the disintegration of ordinary atolls. Agassiz had always intended, after finishing his explorations of the atoll and coral regions of the Pacific, to make an expedition to these islands, especially as they were the only great group of atolls he had not visited. For this purpose he chartered the steamer Amra of the British India Steam Navigation Company. The vessel was equipped with a Lucas sounding machine, built especially for the voyage, a modification of the type used by the English cable companies, which Agassiz found simpler and easier to handle than the Sigsbee machine he had used on his previous expeditions. She was also furnished with a Bacon winch and a drum large enough to hold eight hundred fathoms of wire dredging rope. This equipment was to be used for deep towing, and such few hauls of the dredge as there might be time to make. As usual, the minutest details of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

the trip were carefully thought out and arranged for far in advance.

On his way to Ceylon, where he was to join the Amra, he spent three weeks in Paris, busy seeing his friends, having his portrait by Lefebvre finished, and as usual mulling over all sorts of projects for the future.

TO SIR JOHN MURRAY

PARIS, Oct. 26, 1901.

I am very glad you are likely to pass through Paris while I am here. Let me know beforehand, if you can, so I may be sure to be on hand.

I begin to feel as if I might have taken Gardiner's say on the Maldives and not go there; still I fancy it's just as well to have a look at them. From his preliminary Report, he must have worked very hard there. If I can make up my mind, I want next winter to explore Lake Nicaragua. I've had it in mind for quite a while. It is said there are sharks and skates and other marine fishes and things! "Quien sabe?" anyway, it is probably a remnant of the sea, elevated in[1] ? times, and one might bring up something of interest by dredging, and collecting there. It's quite accessible via Panama, and in winter the climate there is fine, hot but not unhealthy, and I believe there are a number of small steamers available for the depths of the Lake, which is said to be not more than 130 to 150 fathoms.

Agassiz sailed from Genoa on November 26, on the Prinz Heinrich, taking with him as assistants his son Max, Dr. Woodworth, and Dr. H. B. Bigelow.

[1] Left blank in original.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

TO HIS SON RODOLPHE

COLOMBO, Dec. 21, 1901.

We are off this P.M.; we got here the 16th — three days late, owing to endless delays from freight accumulated at intermediate ports going to China. We found the Amra quite as far ready as I expected. They had made all the alterations I had asked for — the sounding machine and the dredging winch were set in place, coal on board, most of the provisions, and there only remained a few little changes and additions and supplies to lay in to have her O. K.

The British India people, from whom I charter the Amra, have been most attentive and thoughtful. The Captain (W. Pigott) is one of their best men, commands one of their largest passenger steamers, is a really nice chap, very gentlemanly, and full of interest in the trip. He has been to the Maldives several times, and is a great friend of the Sultan's. The Amra is about as big as the Albatross. We all have excellent cabins, a fine place to work on the upper deck, amply protected by a wooden awning from rain and sun, where we have a huge table to sort our specimens. We expect also to dine on deck in ordinary weather, as saloon below may get a little warm; electric lights, punkas, bath-rooms. The officers are nice young chaps, also engineers, and we take ten additional men as boat's crew and for carrying photographic apparatus, in place of a steam launch! We have no end of drinking stuff, wine, soda, etc. Of course our ice will give out first, but we shall get used to going without, as we have had to do on other expeditions. She is provisioned for three months, and carries coal for two months. So I expect to be able to stay out

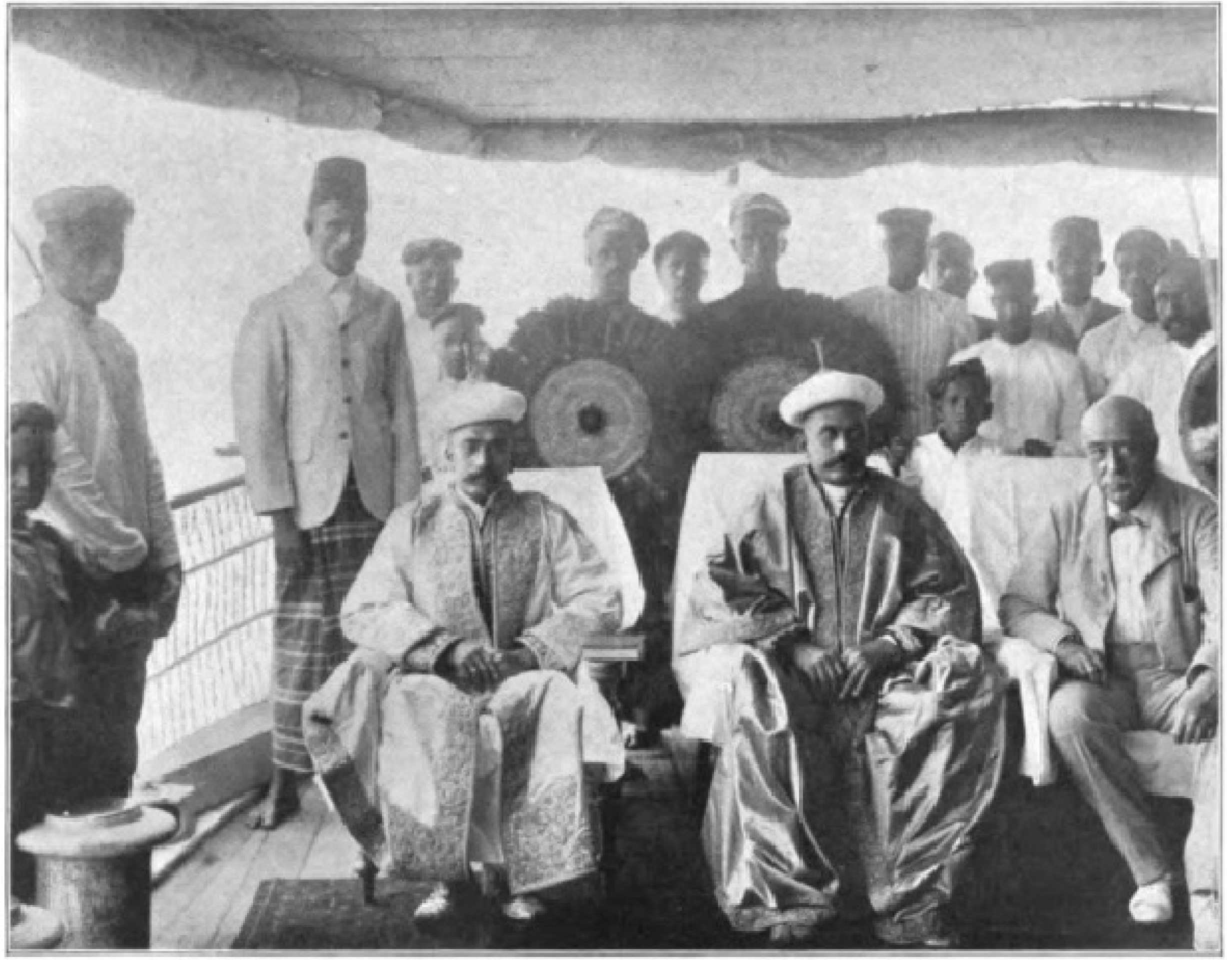
Digitized by Google Original from UNIVERSITY OF MICHIGAN

of Colombo long enough to do all I want without having to come back for supplies. The Amra is fully as comfortable as the Albatross, and it makes me sick to think I might ten years ago have built such a boat for my work and have had no complications with Government officials. Still I have had my work, if not exactly as I might have had it — owning a boat would not have cost me a bit more in the long run. But it's too late now to begin.

Agassiz had letters from the English government to the officials in Ceylon, who notified the Sultan of the Maldives (an independent protectorate of Ceylon) of the proposed expedition. The Amra made directly for the capital of the group, the small island of Male on the southeast rim of the atoll of that name. Most of the little island, perhaps a mile long and nearly half a mile broad, is covered by an old ruined fort, all that remains of the attempted occupation of the Maldives by the Dutch and Portuguese. On the northwest face of the island is a breakwater enclosing a little harbor which affords shelter for native boats. An open space leads up from the landing to a solid wall of coral limestone that surrounds the Sultan's palace, a rambling structure of the same material, half bungalow and half castle, with overhanging eaves and a corrugated iron roof. The rest of the island is covered with the native village; its neat streets shaded with magnolia, banana, bread-fruit, and other tropical trees, under whose shade the bamboo-framed houses, covered with thatch, rest each in its little courtyard carefully fenced off with cocoanut leaves.

After lunch on the day of their arrival the whole

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN



THE SULTAN ON BOARD THE AMRA

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

party went ashore to pay a visit to the Sultan. They were shown into the throne room paneled with polished teak, and furnished with a few teak chairs, and a gorgeous gilded armchair. The walls were decorated with a number of phonographs on shelves, and a quantity of cheap clocks! Presently the Sultan came in, a striking and intelligent figure, dressed in embroidered green satin, with a green brocade turban crowned with a gold aigrette. Agassiz presented his letters and offered some presents that he had brought especially for the occasion. The Sultan asked a few questions, through his Prime Minister and interpreter, in regard to the objects of the expedition. When the audience was closed, and the rest of the party had left, the rigors of court etiquette were relaxed, and the Sultan consented to defeat Agassiz at a game of chess. In the evening the party again went on shore and entertained the court with a display of fireworks and some lantern slides!

The next day the Sultan with his brother came on board in full state in the court barge. She was manned by twenty oarsmen; on a raised poop in the stern the Sultan and his brother stood under white umbrellas, surrounded by their suite. Attended by two fan-holders, and a man carrying his shield and another his sword, the Sultan inspected the ship, and showed a most intelligent interest in the sounding machine and the apparatus for towing and dredging. At the end of the visit, Agassiz gave him a copy of "Three Cruises of the Blake" and a revolver!

Before the Amra left, the Sultan gave Agassiz a circular letter to all the chiefs of the group, and furnished him with an interpreter, and a representative in the person of one of his ministers. The latter proved a doubt-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

ful blessing, developed a taste for alcohol, and caused trouble among the natives because he fancied they were not treating him with sufficient consideration.

A small chart, in the corner of Chart 1, gives an idea of the ship's course through the group.[1] The archipelago consists of a chain of atolls, which is double along its central portion, and extends from Lat. 7 N. to about fifty miles south of the Equator. The group is said to contain 10,000 islands, though this is probably an exaggeration. A glance at the diagram, on the opposite page, of a so-called composite atoll of the region will show that navigation through such lagoons is by no means easy. A good deal of planning was necessary to lay out the voyage to advantage. In order to explore a lagoon, the sun must be in certain positions to detect the shoals from the color of the water. One cannot steam east in the morning or west in the afternoon. To take photographs successfully the eastern face of an atoll must be explored in the morning and the western in the afternoon. Finally the programme must be so arranged as to reach an anchorage before sunset, so selected that the sun will be in a favorable position the next morning to continue observations without loss of time.

The inhabitants of the Maldives are all Mohammedans; it was the season of the Ramadan, but no religious austerities could greatly interfere with such a wonderful event as the arrival of a European steamer: indeed, in some of the islands at which they touched the natives had never seen a white man. Everywhere the explorers were received with friendly curiosity by the men, who,

[1] This chart is of earlier date than the larger scale charts used on the expedition, and the spelling of most of the names is different.

Digitized by Google Original from UNIVERSITY OF MICHIGAN



COMPOSITE DIAGRAM SHOWING THE CHARACTERISTIC FEATURES OF MALDIVE ATOLLS

The blue portions represent reefs and flats anywhere from barely or nearly awash to a few fathoms under water.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

mindful of the religious obligations of their womenkind, kept them as much out of sight as possible.

The geological conditions found in the Maldives reminded Agassiz of those existing on the Yucatan Bank, except that in the latter region the shoals are far less numerous and the coral formations fewer and less developed.[1]

Far from being in a region of subsidence, Agassiz was able to detect from the position of the modern conglomerate beach rock in the Maldives traces of a slight elevation in many widely scattered parts of the groups. Another objection to the theory that these atolls have been formed by subsidence would appear to be shown by the uneven nature of the bottom developed by the soundings in the vicinity of the atolls, which show that there are great differences in the depths of the banks. This, on the theory of subsidence, would mean a very improbably great and uneven difference in the subsidence within short distances, while Agassiz always maintained that the theory demands a gradual and even subsidence. The topography of this great Maldivian Plateau is, however, no more irregular than that of any mountain plateau that has not been elevated above sea level.

Agassiz found the Maldives to be situated on a submarine plateau on whose secondary plateaus corals have established themselves wherever the bank is sufficiently shallow to permit of their growth. The colored plate shows the general appearance of a characteristic Maldive atoll. It will be noticed that the rim is composed

[1] Agassiz considers that the reason the Alacran Reef is the only real atoll on the Yucatan Plateau is because the locality is not in the region of regular trades or monsoons.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

of a number of small atolls, called "faros" by the natives, while the interior is studded with faros, shoals, and islands. The peculiar conditions found in the Maldives are probably due chiefly to the alternating northeast and southwest monsoons, which convert a weather into a lee shore, and vice versa, and set up alternating currents in the lagoon; thus creating forces which contribute in a great measure not only to the shape of the shoals upon which the corals have started, but to the growth of the corals themselves. This view is strengthened by the fact that in the southern part of the archipelago, which is outside the region of monsoons, the atolls are very similar to some of those in the Pacific. In the Maldives, however, the corals have grown up from banks at a suitable depth, while in the Paumotus, for instance, the foundations for the corals have been cut from ledges of a once greater height. That corals grow with unusual luxuriance within the lagoons, in marked contrast to the scanty growths in atolls of the Pacific, accounts for the many faros and flats found in the Maldives. The numerous wide passes between the faros on the rim of the lagoon allow a very free circulation of water, which renders the conditions within the lagoon more favorable for coral growths than in most lagoons elsewhere; the immense bodies of water that the monsoons force across these lagoons are also a very considerable factor in the formation of the composite atoll.

From his anchorage at Male, Agassiz had his first view of those remarkable rings which form such a characteristic feature in the coral reef scenery of the lagoons of the Maldives. These rings, bands of shallow, light-colored water, stand out from the deep-blue water

Digitized by Google Original from UNIVERSITY OF MICHIGAN

surrounding them like ghosts of an atoll, and enclose a lagoon, light blue or emerald-colored, according to its depth. These faros are not necessarily circular; they vary greatly and are indirectly controlled by the topography of the bottom. When nearly circular, there have probably been no agencies to interfere with the symmetrical growth of the coral. Some of the inner faros are elliptical, pear-shaped, or crescent-shaped, but as a rule they are much more symmetrical than the faros of the outer rim, which are distorted by the full force of the monsoons.

The ring-like faros are apparently formed by the upward growth of circular or elliptical patches of corals occupying slight elevations above the general level of the surrounding plateau. These patches may grow up uniformly to form a bank, or they may grow up as rings, the corals of the outer face only rising toward the surface, those in the centre being killed by want of clean water and food, or choked with sand that is washed into the interior, which is filled more slowly than the growth of corals on the rim. When the rim reaches the surface it may develop in two ways. In one case, the lagoon may gradually fill in and be changed into a flat with an islet or islets forming on its rim; these may slowly grow to cover the whole reef flat. The islets become covered with scant vegetation from the adjacent faros; with the growth of the land, large trees will obtain a foothold, till at last what was once a submerged faro will be transformed into a densely wooded island. In the other case, a sand bar may form a little islet or islets on the rim of the lagoon; these islets are gradually joined together and become crescent-shaped, the horns throw out spits (much as the horn forming Provincetown Harbor has

Digitized by Google Original from UNIVERSITY OF MICHIGAN

grown on Cape Cod), until there is only a narrow passage between them; finally both horns unite and form a land rim completely enclosing a lagoon and there results the so-called ideal atoll, so rarely seen but so often described. The growth of the land rims appears to be fairly rapid, for several changes could be observed during the seventy years since Moresby's surveys. Some faros, shown on the chart as entirely submerged, were found to have little islets on their rims; islands were found to have grown into crescents, and in one case a crescent was found to have completely closed about its lagoon.

In like manner the faros forming the rim of the composite atolls have grown up on the edge of the secondary plateaus of the great Maldive Plateau; here the faros, owing to their favorable position, have obtained a more extensive development, the unusually free circulation of water permitting an abundant growth of coral on their inner faces. Some of the lagoons of the faros of the outer rim have been formed by the growth of coral patches or lines of corals rising parallel to the outer reef flat a short distance lagoonward. These patches become joined and thus form elongated lagoons on the outer reef flats.

A number of tows were made in the lagoons, and as might be expected from their open character, the life there was found to be abundant. A number of intermediate hauls were also made off some of the principal passes. Several of the hauls[1] seem to have been richer in masses of varied material than any Agassiz had brought over a ship's side since the old days in the

[1] Intentionally somewhat limited, as Agassiz could not expect to add much to the extensive collections made by Mr. J. Stanley Gardiner during his prolonged stay in the Maldives.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Blake when he worked along the edge of the Gulf Stream. No attempt was made to collect any plants. But Agassiz calls attention to the fact that the flora of the Maldives must have been much modified by the activity of the inhabitants, who maintain a considerable trade with the Malabar Coast and Calcutta. This, rather than the effect of oceanic currents, is probably the direct cause of the introduction of many Indian and even Arabian species.

On the way north the Amra again stopped at Male. It was the end of the Ramadan, and the party arrived just in time to witness a curious procession to celebrate its close. Prominent in the line were grotesque dancers, primitive spearmen and the gorgeous royal palanquin supported on the shoulders of twelve men, and surrounded by twirling umbrella bearers. A feature of the parade was a horse, the only one on the islands, imported by the Sultan from Colombo. He was led by two men, as nobody dared to ride him.

The Sultan seemed much interested to hear of the results of the expedition, and before the ship left gave Agassiz a fine collection of the implements, tools, utensils, cloths, and dresses of the islands. His Highness, Muhammadu Imadudin, evidently retained a pleasant memory of the visit of the Amra, for the Christmas after Agassiz's death a card arrived at the Museum, from the "Ex-Sultan of the Maldives" in exile in Cairo.

TO SIR JOHN MURRAY

OFF NALANDU, SS. AMRA, MILADUMMADULU ATOLL,
Jan. 18, 1902.

Two days more and I shall head for Colombo where I mail this letter on arrival. We are due there the 23d.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

This will be the end of a most successful expedition, perhaps to me the most interesting visit to a coral reef group I have made — for certainly I have learned more at the Maldives about atolls than in all my past experience in the Pacific and elsewhere. I should never have forgiven myself had I not seen the Maldives with my own eyes and formed my own opinion of what they mean.

Such a lot of twaddle as has been written about the Maldives. It's all wrong what Darwin has said, and the charts ought to have shown him that he was talking nonsense. I am afraid Gardiner also came down with a theory and saw much that he wanted to see. But Gardiner's and Cooper's patience and endurance to accomplish *what they* did are beyond praise. At any rate, I am glad that I always stuck to writing what I saw in each group and explained what I saw as I best could without trying all the time to have an all-embracing theory. Now, however, I am ready to have my say on coral reefs and write a connected account of coral reefs based upon what I have seen, and it will be a pleasure to me to write such a book and illustrate it properly by charts and photographs. But it will be quite a job with my other things on hand. I hope to live to 100! — or rather I don't hope but ought to! — to finish all.

The Captain was a regular trump, full of interest in all that was doing, an excellent photographer, a good mechanic, and he has now become an expert coral reef navigator, as good as any man I have sailed with as pilot in the South Seas. He took special charge of the sounding machine, and attended to everything and became an expert; he often sounded when I should have hesitated to do so; he only lost forty fathoms of wire making eighty soundings, quite a number near fifteen hundred

Digitized by Google Original from UNIVERSITY OF MICHIGAN

fathoms. I paid special attention to sounding all the channels and a few lines at right angles to the Plateau of the Maldives.

The weather has been superb — we lost only one day. Taking all our meals on deck, we were driven below only one day in the South Maldives at Addu, where it always blows and rains pitchforks. The Sultan was most attentive and so were all the natives.

Agassiz had now visited practically all the important coral reef regions of the world, and in no single instance had he seen an atoll or barrier reef whose formation he thought could be satisfactorily explained by subsidence. It naturally followed that his final conclusion was a total dissent from Darwin's theory on the subject.

It had always been Agassiz's intention to embody his coral reef investigations in a semi-popular summary; somewhat such a treatment of the subject as the "Three Cruises of the Blake" was of oceanography. This unfinished book caused him much trouble; he never took kindly to semi-popular work, and although in the last few years of his life he was constantly returning to it, he was not convinced of its utility. He used to say that all his views on the subject could be found in his various reports; he did not realize that those interested in such matters were waiting for him to summarize his work.

He is thought to have recast the book more than once. The material he left furnishes an excellent example of his method of carrying his work in his head until the last moment. At his death nothing could be found but a vast collection of extracts from the literature of the subject marked and scored, and a few

Digitized by Google Original from UNIVERSITY OF MICHIGAN

rough notes, of no use to any one but himself. Even though this book can never be written, the splendid volumes describing his coral researches will remain as a lasting monument to his widely extended and exhaustive study of the question in the field, such as has not been even approximated by any other man.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

CHAPTER XVIII

LATER YEARS

In later years Agassiz spent but little time at Cambridge, for in the winter when not on an exploring expedition he took his work with him to Europe, which he always felt offered a much more congenial atmosphere for a man of science, or he made a journey to some milder climate. In spring and fall he paid his regular visits of inspection to Calumet, while his summers were passed on his place at "Castle Hill." As the years went by, he spent more and more of his time at Newport. The climate agreed with him, he was devotedly attached to his place, and seemed to get a contentment and peace there that he did not find elsewhere. As the span of his life drew toward its close, he lived there somewhat less strenuously, and delighted, with the freemasonry that exists between the young and the old, in the companionship of his two little grand-daughters who paid him long visits.

His mornings were spent in attending to any business matter that might turn up, and in working on the reports of his expeditions. In the latter part of his life he rarely worked much in the afternoon when at Newport. Until the trouble with his knee prevented it, he usually went out on horseback; when he was obliged to give up this exercise, he took to golfing on a little course that he had set out on the place. He often spent an hour or two pruning his trees, in which he took much interest, for he had transformed the bare little peninsula into a miniature

Digitized by Google Original from UNIVERSITY OF MICHIGAN

forest. Occasionally he would drive into town to call on a friend.

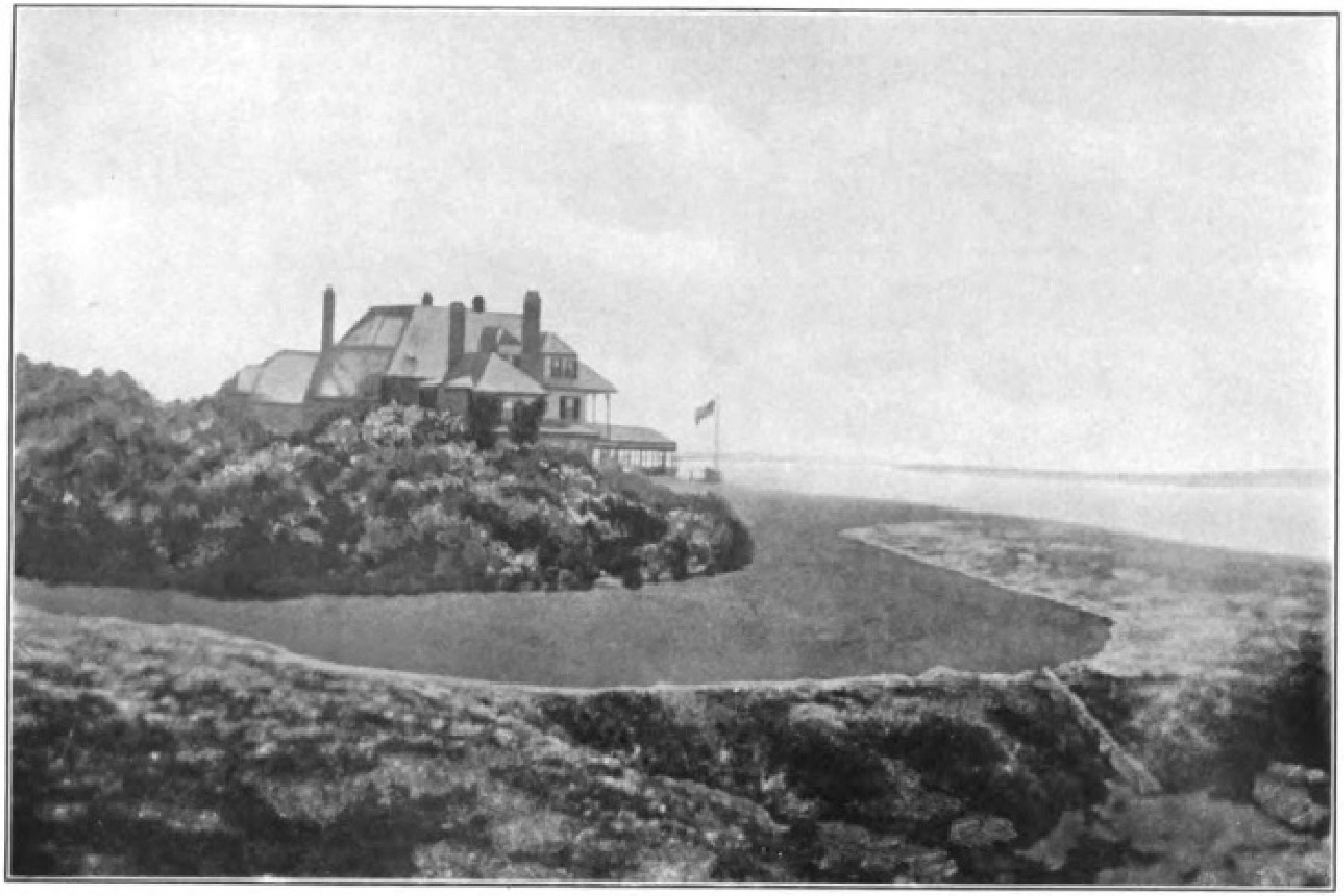
In the evening, when he did not have a few people to dinner, he usually dined elsewhere, for his never-failing charm, a dominant trait, as universally recognized as it is impossible to describe, made him a welcome guest at many boards. Once at some social gathering in Newport, when a vote was taken as to who was the most agreeable man at a dinner, the overwhelming majority was for Mr. Agassiz.

The giving of little dinner parties became one of his chief recreations in later life. He took the greatest interest in seeing that all the details were as complete as possible, and always brought the wine up from the cellar and decanted it himself. On special occasions, the table was lighted by two magnificent candelabra, said to be copies of a pair by Benvenuto Cellini, which he had bought as a souvenir of a scientific prize.[1] As he presided with evident pleasure over one of these festive little feasts, at a table set with old silver, which it was one of his hobbies to collect, an attractive woman of the world on either hand, he sometimes referred to the little chap who used to trudge between Neuchâtel and Freiburg because he was too poor to pay the stage-coach fare.

There was nothing of the ascetic about him; he enjoyed a good dinner and cultivated, congenial society. Both his Newport and Cambridge houses were models of comfort filled with the choicest collections of the best art of China and Japan, collections begun in the days when such treasures were less appreciated than now and more easily acquired.

[1] The Prix Serres, awarded to Agassiz in 1879, by the French Academy of Sciences, for his embryological work.

Digitized by Google Original from UNIVERSITY OF MICHIGAN



"CASTLE HILL," NEWPORT

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Perhaps the hardships of his youth enabled him more fully to appreciate the comforts of his later life. But not one cent did he ever spend for ostentation, nor did his surroundings ever in any way affect the simplicity of his life or the efficiency of his work.

Money to him was chiefly valuable in that it enabled him to grasp wider scientific opportunities, and build up in the Museum a great institution for study and research in science. His ample fortune he poured out lavishly for science. He would hesitate over the price of a horse, while he bought without a thought, for many times the sum, the fossil bones of its remote ancestor.

During his life his contributions to the Museum and the University amounted to over a million and a half dollars, and a further very considerable sum will eventually revert to Harvard University for the use of the Museum. His attitude on the question of his expenditures for science is well shown in a few lines from a letter to Murray: "While the sum total seems a large expenditure and one which appeals to the public and to the University officials, I hope that my influence on science at Cambridge will not always be measured by the dollar standard, as it is so apt to be. What I care for far more is the recognition of the fact that having the means I have backed up my opinion of what was worth doing by a free expenditure of funds, and furthermore, that I have since 1870 devoted my time as completely to the interests of the Museum as if I had been working on a salary of 1500 a year. And that since that I have published the results of my work continuously and hope to be judged by that and not by the total I may have spent for the same. I want to go down as a man of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

science and not to be temporarily known by a kind of cheap notoriety as an American millionaire."

While pouring out his fortune for science with one hand, he was generous almost to a fault to his children with the other, when he had once satisfied himself that they were not likely to abuse his liberality. If they sometimes laughingly expostulated at some piece of parental extravagance in their behalf, he always replied with his irresistible smile that he wanted to be sure his sons were not waiting for him to die.

On his way home from the Maldives he spent several weeks in Paris. "I have worked like a beaver while here," he writes, "and have practically finished my report on the Maldives — it now only needs reference to literature, and the getting up of charts and photographs to have it ready for the press. I am mighty glad to have it off my hands while it is fresh in my mind." In another letter he writes: "Somehow I am feeling the reaction of this trip. I have no appetite and have lost fourteen pounds since reaching Paris, but the doctor says there is nothing out except that I have worked a little too fast."

On his way home, via England, he ran up to Edinburgh to deliver an address on Coral Reefs before the Royal Society of Edinburgh. From his plans for that event, as sketched in the following letter, it does not appear that he contemplated working less strenuously.

TO SIR JOHN MURRAY

PARIS, March 3, 1902.

I returned here a couple of days ago and find your letter of February 12. It's too bad about the condition

Digitized by Google Original from UNIVERSITY OF MICHIGAN

of the Manganese Nodules. I warned the Fish Commission specially about the labels and the danger of their being rubbed to pieces. But they are hopeless there, nobody to care for anything. I may help you from my original notebook when I get home. At Edinburgh all I can do is to guess with the assistance of the list of soundings where nature of bottoms is mentioned.

I am getting cables daily from Boston — things look pretty squally in copper line. My chief stay in the office has just been ordered off South, and I don't yet know if they can hold their breath till middle of April or thereabout. I don't want to go home if I can help it, for I feel the reaction from the warm weather and am pretty well used up. I could not stand one of our blizzards.

My youngest son, Rodolphe, just telegraphed me he is to be in London the 27th, with all the figures and facts and suggestions, so that if nothing unforeseen occurs before he sails, the 17th, I can stay here till then and then take the first steamer for New York. In that case I should meet him in London the 28th, 29th, go to Edinburgh *Sunday night*, the 30th, give my Address the next afternoon at 4, go to the dinner at 7.30, and return if possible by the night train to London. I think there is one at 11 P.M.?

If you will kindly drop me a line if that is possible, I might by time I got your reply be able to say yes or no. Glad to hear from you that my Preliminary Report of Pacific pleases you and looks well. Hope you got the little Maldive pamphlet I sent from Ceylon.

On his return to America he paid his usual spring visit to Calumet, from whence he writes: —

Digitized by Google Original from UNIVERSITY OF MICHIGAN

TO HIS SON RODOLPHE

Since I wrote you I have had two additional interviews with MacNaughton [the general manager]. I like him, and I now feel as if my orders would be carried out promptly and not appear year after year on my list of things to be attended to. He is only 37 and gets—— a year to begin on. This is three times what I was getting when I left Calumet at 33, after having opened and developed it. Such is the difference between men and times now; I little dreamed I should ever offer my successor here such a salary.

To-day is a fair sample of the work I do, though it is perhaps a little mixed — talked with W—— an hour — went to smelting works — saw head clerk there who wants to go to Congress — saw the superintendent of the stamp mills — had a confab with the Lake Linden School Board — another with the village authorities of the Lake — inspected the new timber mill — made a visit to the Assay Office — came up to mine to have an interview with the Catholic Bishop of Marquette — got up contract for Electric Street Railroad — had a long session with MacNaughton — another with Electric people — one with aid fund superintendent, and then went to take a long walk before dinner to visit adjoining mines.

One interesting result of Agassiz's periodic sojourns at Calumet was a series of experiments on underground temperatures, undertaken with the assistance of the engineer of the mine, Mr. P. C. F. West. Ever since mining had meant more than a mere scratching of the surface of the earth, men must have realized that

Digitized by Google Original from UNIVERSITY OF MICHIGAN

the temperature of the earth increases as we dig into it. From hitherto recorded observations Lord Kelvin had assumed that the temperature increases 1° F. for every 51 feet of depth; while observations in the St. Gotthard Tunnel gave an increase of 1° for 60 feet. From these observations it had been calculated that the crust of the earth would be about 20 miles thick for Kelvin's gradient, or about 26 miles for the other.

The deepest point in the Calumet Mine at the time of this investigation was 4712 feet (vertical depth). Holes ten feet deep were drilled in the rock at various points from 150 feet to 4580 feet, standard slow-registering thermometers were inserted, the holes plugged with wood and clay; and the thermometers were left from one to three months. The temperature of the rock at 4580 feet proved to be only 20° F. hotter than that at 150 feet. This gives an average of 1° F. for 223.7 feet, which by the same reasoning as that based on former experiments would give a thickness of the earth's crust of over 80 miles, instead of 20 and 26 miles. Agassiz never offered any explanation to account for the extraordinary difference in his temperatures from those obtained in other parts of the world, though it has been suggested that it might be due to the cooling effects of the neighboring waters of Lake Superior. He once said, however, that the article had given rise to more annoying correspondence than anything else that he had ever written.

In the fall of 1902 the friends of Mrs. Louis Agassiz arranged for the celebration of her eightieth birthday by subscribing to a building for Radcliffe College, of which she had long been President. A concert was also given in her honor at the theatre in Memorial Hall. As

Digitized by Google Original from UNIVERSITY OF MICHIGAN

she entered on the arm of her son, the audience rose in a body as a mark of respect for her. In speaking of the event afterwards she said that she felt rather nervous on entering the hall, but when she saw everbody getting up to do honor to Alex, it put her completely at her ease!

TO MRS. G. R. AGASSIZ

CAMBRIDGE, Dec. 17, 1902.

We were all glad to hear that you were safely settled in your new quarters, and we imagine you sitting out while we are wading through the snow, a regular old-fashioned snowstorm which has badly complicated the coal question and made the delivery of the little coal there is all the more difficult. I am just beginning to get ready for Saturday's sailing per Ivernia. It will be quite a new experience for Max and me to sail from Boston in a Cunarder and in a slow boat. But there was nothing better till after New Year except a French liner and I have distinct prejudices against them.

Last night I read the proof of the last page of the index of my Report on the Pacific Coral Reefs, so I shall have everything in good shape to be published as soon as practicable in my absence.

Mother will have written you about the concert at her birthday; it was a great success, the finest thing being A. Ag. sitting through the whole because he could not get out! and surviving the ordeal. The public raised $65,000 for the building, to be called after mother, so that with the $50,000 of the family they can put up something creditable, but will have little to run it with. The élite of the beau monde came to the house after the concert and stayed well on towards midnight. Mother

Digitized by Google Original from UNIVERSITY OF MICHIGAN



ELIZABETH C. AGASSIZ

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

is none the worse for all this, in fact would like a second festival, provided it could be as lucrative as the first.

TO SIR JOHN MURRAY

On Board the Ivernia,
Dec. 29, 1902.

Here I am off Queenstown, due in London Tuesday night. I only expect to be there very few days and run south. Have you come across any very good sounding machine for moderate depths? say 20 to 30 to 100 fathoms, with a cup to collect a good lot of stuff from the bottom? I want to make a lot of soundings on our pile of tailings (at Calumet) which has accumulated for thirty years and more, and find out where the valuable part has been deposited off our mills in from 10 to 50 fathoms, and want a good cup or clasper. My idea was a Thomson machine such as yachts use and a telegraph company clasper. What do you say? I 've brought with me a number of the most interesting of the Plates of my Pacific Report, as well as of the maps, which I hope to show you before I turn back to the United States, though my Report ought to be out March 1, unless the printer is delayed by the paper, and I have told them to mail you a copy at once on its issue. I shall be in London at Long's Hotel, as usual, and at Athénée in Paris, my stay at each depending on the copper people I have to see — and I hope to get to Sicily later and then out.

My chirography is worse than usual, thanks to the rolling of the ship. Drop me a line to Long's regarding the sounding machine, as I want to send one home at once to use while our Lake is frozen.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

TO MRS. G. R. AGASSIZ

PARIS, Feb. 2, 1903.

Max and I have been here since the first days of January, most comfortably settled in our old quarters at the Hôtel de l'Athénée. It looks very much as if we should stick here. The weather has been superb, with the exception of a short cold snap lasting only a couple of days. There can't be much more cold here, and as I am getting on well with my new work here I'll stay and do all I can to it here so as to get rid of it next summer. For though I've got out — or it's getting out — my Pacific Report, I always keep something of the kind on tap. What I am at is the Maldive Report, which will not stagger my friends with its bulk, as will undoubtedly the Pacific book; and besides that there are quite a lot waiting. With good care, husbanding my resources, there is enough material to last long enough for me to know that I had better stop and say no more.

I don't know if you have seen the Louvre since they have rearranged it. It's a very great improvement and one can see well all the good things there are in it. The great objection to going on rainy days, as I do, is that all the loafers of Paris do the same to keep warm, and it makes it pretty uncomfortable for ladies. All the settees are occupied by the dubious crowd and they cover the floors with mud.

The other day when at the Français, one of my friends who knew the Director took me all over the artists' foyer to see the relics and pictures, etc., of the theatre from the days of Molière to the present time. It is queer that for a man who wrote as much as Molière there should only be left a single letter, but then they have his

Digitized by Google Original from UNIVERSITY OF MICHIGAN

lower jaw! in a case. The portraits are most interesting, a fine one of Rachel which recalled the days when I was a Supe in college, at the Old Howard, as the only method available of seeing her act. I quite remember her chaffing me for my looks as a "sacré le natif romain!" 'T is a wonder that when they had the fire a few years ago they were able to save all this stuff undamaged.

I have been to dine with several of my friends of the French Professors. I feel quite at home with some of them.

I wish you and George were here — what a nice quartette for theatre parties we would make.

I envy you your warm weather, but I ought not to complain. I shall need heat so much if I don't get a little cold occasionally, that nothing but the infernal regions will satisfy me next.

TO ERNST EHLERS

PARIS, Feb. 2, 1903.

I heard incidentally the other day that you are coming to Paris to see Darboux about some matters connected with the International Association of Academies, so I write this to let you know that I am here and to say how much I hope the report is true, and that I may have the pleasure of seeing you again after so long a while. But if you are not coming now, perhaps you will be one of the delegates of the Göttingen Academy at the London meeting next year (1904). I think I shall appoint myself[1] as one of the delegates of the National Academy of Sciences of Washington, so as to see my German friends and colleagues. I also intended before leaving Cambridge to ask you for the address of your son-in-

[1] As President of the National Academy of Sciences.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

law — is he still at Heligoland? I wanted to write to him and ask him in regard to his Report on the Comatulæ he has in hand from the days of Carpenter.

A few days before leaving Cambridge I completed my big Report on the Coral Reefs of the Pacific and copies of it ought to be sent out by the end of March, of which you will get one in due course. This leaves me only my Report on the Maldives and a general résumé of the whole Coral Reef question, both of which I hope to get out within the year, and then I shall go back again with renewed vigor to my Deep-Sea work. I have a huge Report on the Echini of the Albatross (1891 Ex.), of which nearly ninety Plates are completed, and I hope to go off on another and last expedition to the Pacific to explore the great gap of unknown territory left from Panama to Paumotus and Paumotus to Peru, after which I shall be getting too old to run off in that way, and I shall have to be satisfied with shorter expeditions nearer home, to the West Indies where there is still much to be done. I am hoping to interest the new Carnegie Institution, of which I am one of the Trustees, to join me in this last great Pacific Expedition, but the great trouble is to get efficient assistants, and then to have the mass of material obtained worked up by competent naturalists.

On his way home he delivered a lecture, before the Royal Society, on Coral Reefs — and in the discussion afterwards it was clearly brought out that he had not in all his wanderings seen a single atoll or barrier reef whose formation he could explain by subsidence. Agassiz was, however, disappointed that there was not more discussion, as most of the members of the Royal Society

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

who knew about corals were connected with the editing of the report on the boring at Funafuti, which had not yet been published, and could not be anticipated.

In the spring of 1903, Agassiz proposed to Professor H. L. Clark that he should collaborate with him in his work on the Echini. This proposal was accepted by Professor Clark, who became a member of the Museum staff, and most of the Echini collected on Agassiz's trips after 1891 were studied in collaboration, and published with those collected by the Albatross in Japan and Alaska under the title of: "Hawaiian and Other Pacific Echini;" several parts of this series of reports were in preparation at the time of Agassiz's death. In 1908, Agassiz published an elaborate memoir with forty-nine plates on the Genus Colobocentrotus; and a proposed memoir on Echinonëus and Micropetalon, prepared for publication by A. M. Westergren, appeared in 1911. The condition in which the material for the last-named publication was left, illustrates well Agassiz's methods of work; for although he had been contemplating it for some time, and the illustrations were nearing completion, yet not a scrap of text was to be found. Nevertheless, it was probably nearly ready for the press, for Agassiz, like his father, had the habit of carrying his work in his head, indeed, he often carried along in this way and at the same time several pieces of work.

He was greatly bothered in the summer of 1903 by the old trouble in his leg, brought on again by over-exertion at Calumet that spring, while on his tours of inspection underground. About the middle of June he writes from Newport: —

"While out West early in May I managed to badly

Digitized by Google Original from UNIVERSITY OF MICHIGAN

sprain my leg and have been in bed for nearly three weeks and am just out now, past week, on crutches. This is going to be a slow job and will greatly interfere with my work this summer. It will postpone the Maldive Report if I don't get better quicker than of late, and the doctor does not encourage me greatly. I had the other day an offer from the Carnegie Institute to undertake an Expedition to survey the Tropical Pacific — Geology, Botany, Anthropology, Zoölogy, including the sounding of the great Eastern Pacific triangle, Acapulco, Manga Reva, Callao, with intermediate lines Manga Reva to Galapagos: Galapagos to Easter Island: Easter Island to Callao, on supposition I could get the Albatross, the Carnegie giving me $50,000 to equip her and $100,000 a year for the Expedition for five years! Had this come five years earlier I would have jumped at it. But I shall be nearly sixty-nine in November, 1904, which is earliest time we could start, and I fear I must say no, though I feel greatly tempted to do the Eastern Pacific work and leave to others the rest, such as sounding and dredging round each oceanic group and carrying on the shore biological matters, though it would be mighty interesting to dredge each group into deep oceanic water adjoining, judging from the Echini I have just received from the Hawaiian Islands, which cover that ground."

Agassiz again passed the greater part of the winter of 1903–04 in Paris; he was already busy over the preparations for his next expedition, nearly a year away; much of his time was spent in working on his Panamic deep-sea Echini, which had been delayed for over ten years by his coral reef work. These occupations were lightened

Digitized by Google Original from UNIVERSITY OF MICHIGAN

by other distractions: "I have been to see most of my friends," he writes, "and am quite in the swim." The Panamic Echini was published the following November: it contains a description of the Echini collected on the Albatross Expedition of 1891, and a comparison of the Echini found on both sides of the Isthmus of Panama. From the similarity of the species at moderate depths on each side, he concludes that there must have been a free communication across the Isthmus in comparatively recent geological times down to a depth of about one hundred fathoms, while the species of the continental slopes are so similar to the genera of the Cretaceous period that one can assume a depth of at least two hundred and fifty fathoms in Cretaceous times. Furthermore the abyssal genera are so closely allied to those of the Jurassic period that a still greater depth seems probable at that time.

Towards the end of February, 1904, he writes from Paris: —

"In about ten days I expect to cross over to London with Max, and spend a few days browsing round in the British Museum over some of the deep-sea specimens I want to see again. I 've got a few things to attend to in relation to my next expedition, see the Admiralty people and get all the information possible as to the weather, etc., of a region which is practically unknown."

Writing from London about the middle of March, he says: —

"I have just come back from the British Museum where I had a few chores left in the way of examining some specimens: that 's now done and I 've really fin-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

ished all that I possibly hoped to get through with while on this side. I have seen most of my old friends in London and dined out galore and lunched and clubbed."

One morning in London he was pleasantly surprised to hear that he had been elected, by a very handsome majority, one of the eight foreign associates of the French Academy of Sciences. This is generally considered the greatest honor the scientific world has to bestow, an honor also conferred on the elder Agassiz. With one exception it is the only case where father and son have both been foreign associates.

When, on the death of Bunsen in 1900, there was a vacancy among these foreign associates, Agassiz's name was proposed, but Sir Joseph Hooker was elected, an event of which Agassiz characteristically remarked that Sir Joseph was an older man and a more suitable choice. Again, in 1903, at the death of Virchow, Koch defeated Agassiz by one vote, two of the latter's sponsors being sick. At this election, the Academy appear to have been much influenced by the fact that while Newcomb was the only American Associate, four were Anglo-Saxon, and they did not want another; rather an amusing situation, as Agassiz was born a Prussian.[1]

Among the many honors that he received, his motherland gave him the order of "Pour le Mérite," the highest mark of recognition she had to bestow on a man of science. The foreign membership of this order, so named by Frederick the Great, is limited on its civil side to thirty men chosen from the world of Science, Literature, and Art. It had, since its foundation, been awarded to but nine Americans, including the elder Agassiz. This

[1] It will be remembered that in 1835 Neuchâtel belonged to Prussia.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

was the only decoration that Carlyle would accept. It is especially appreciated by men of the learned and artistic world, because a vacancy in the foreign membership is virtually filled by their peers; for the German knights of the order send the Emperor three names, one of which he chooses.

In the spring of 1908, the Royal Geographical Society awarded Agassiz the Victoria Research Medal. In his absence, the United States Ambassador represented him at a meeting of the Society and received the medal from Major Leonard Darwin, the President. This medal is perhaps the most beautiful of any of its kind. Agassiz delighted in its exquisite workmanship, and with the simplicity of a child would call on his friends to admire it.

At one time President of both the National Academy of Science and the American Academy of Arts and Sciences, with every honor that the learned world of Europe had to offer, honors that were all the more remarkable in that they were never in any way sought by Agassiz, he was undoubtedly better known in America as the head of a great mining industry than as one of the most distinguished scientific men of his generation. He walked unrecognized through the streets of Cambridge, and shared with other men of science in the land of his adoption the fate of being more appreciated abroad than at home, for most Americans seem singularly incapable of weighing at its true value anything that does not lead directly to material ends.

Surely no two American laborers could have filled the rôles of a couple of recently arrived French emigrants, who were once overheard, on a wharf at Newport, commiserating each other on the barrenness of the desolate waste in which they found themselves; one of them

Digitized by Google Original from UNIVERSITY OF MICHIGAN

closing the conversation with the consoling reflection, — "Oh! well, anyway, Mr. Agassiz lives here, and he is thoroughly well known in the civilized world."

Agassiz had resigned the direction of the Museum in 1898, giving his collections and library to the University on the condition that he should retain his work-rooms and certain other privileges at the Museum, including the right to control (and pay for) the publications relating to his expeditions and the collections made on them, which constituted the bulk of the volumes issued.

While his resignation was in part due to his wish to be able to devote more time to his own work, it was also in a degree because of the somewhat strained relations that had crept into his connection with the University. It is unfortunately true that his feelings toward the great Museum, which his efforts and resources had created, were in his later life not untouched by bitterness and sorrow. For years he had carried its development on his own shoulders alone, and in moments of depression and gloom, which were characteristic of his temperament, he would dwell on his lack of support from the outside public, and on the want of sympathy and encouragement from those highest in authority in the administration of the University; till in the end he almost grew to regret the time and energy he had devoted to the realization of his father's dreams, and wished that he had spent his funds in an ampler development of his own scientific work.

In 1900, Agassiz and his sisters, Mrs. Shaw and Mrs. Higginson, presented the University with the funds necessary to build the southwest corner piece of the Museum, completing, with the exception of a portion of the south wing, which will be an extension of the

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Peabody Museum of Archæology, the building originally hoped for by the elder Agassiz.

In speaking of this event, one of his scientific colleagues, in close touch with the Museum, writes Agassiz: —

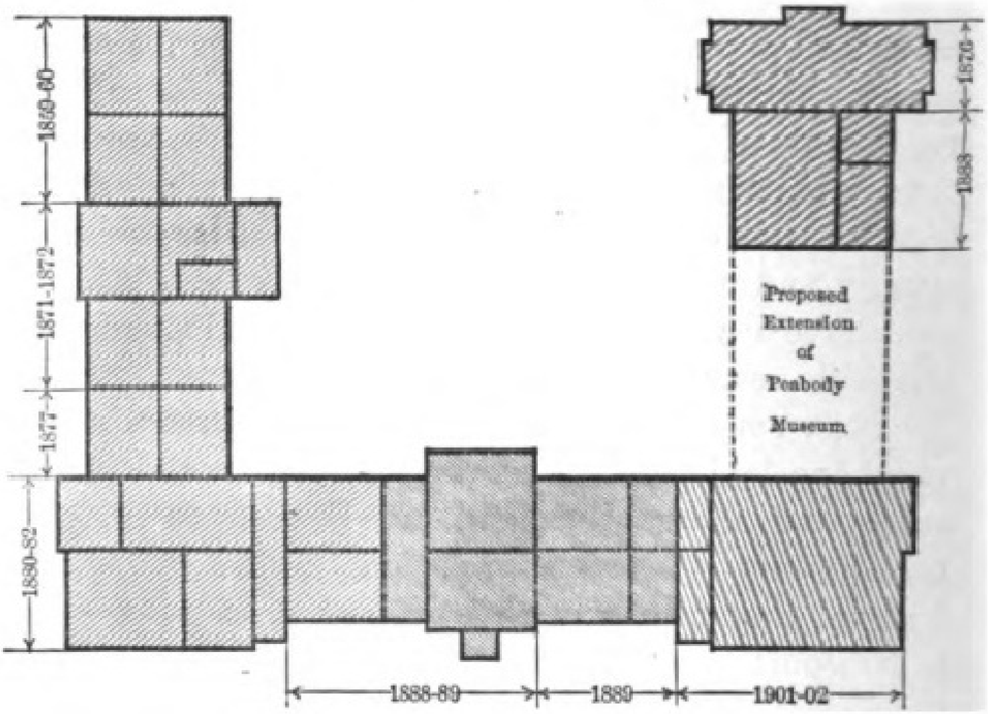
"You are always exciting surprise and admiration. Your stupendous scientific achievements are recognized as equal in amount to many men together, and you have achieved these results of the highest order under conditions of peculiar difficulty. Besides this, you have conducted successfully one of the greatest of the industries on our continent, in itself a work demanding the energy and undivided attention of many men. And yet you have carried on this work in the midst of your scientific research.

"Now comes the greatest surprise of all, namely, that you have laid aside the memory of slights and annoyances and antagonisms, and have decided to complete the museum. This seems to me unrivalled magnanimity. I regret that my absence prevents me from going down to Newport to say so in person, and to assure you that this action appeals to me as exhibiting the highest type of character."

The corner piece of the Museum was finished in 1902; when Agassiz accepted the honorary directorship of the entire University Museum. The opening of the new addition was celebrated by a gathering, at the invitation of the University authorities, of all those who were for any reason interested in the Museum, every one in any way connected with its development, old pupils of the elder Agassiz, and a large collection of the friends of the younger. Agassiz gave a short account of the history of the Museum from the days when his father kept

Digitized by Google Original from UNIVERSITY OF MICHIGAN

his specimens in a shanty on the banks of the Charles. It was all told in so impersonal a way, that one who knew nothing of the facts would have supposed he had no hand in the matter. The celebration concluded with a pleasant and informal tea in some of the larger rooms.

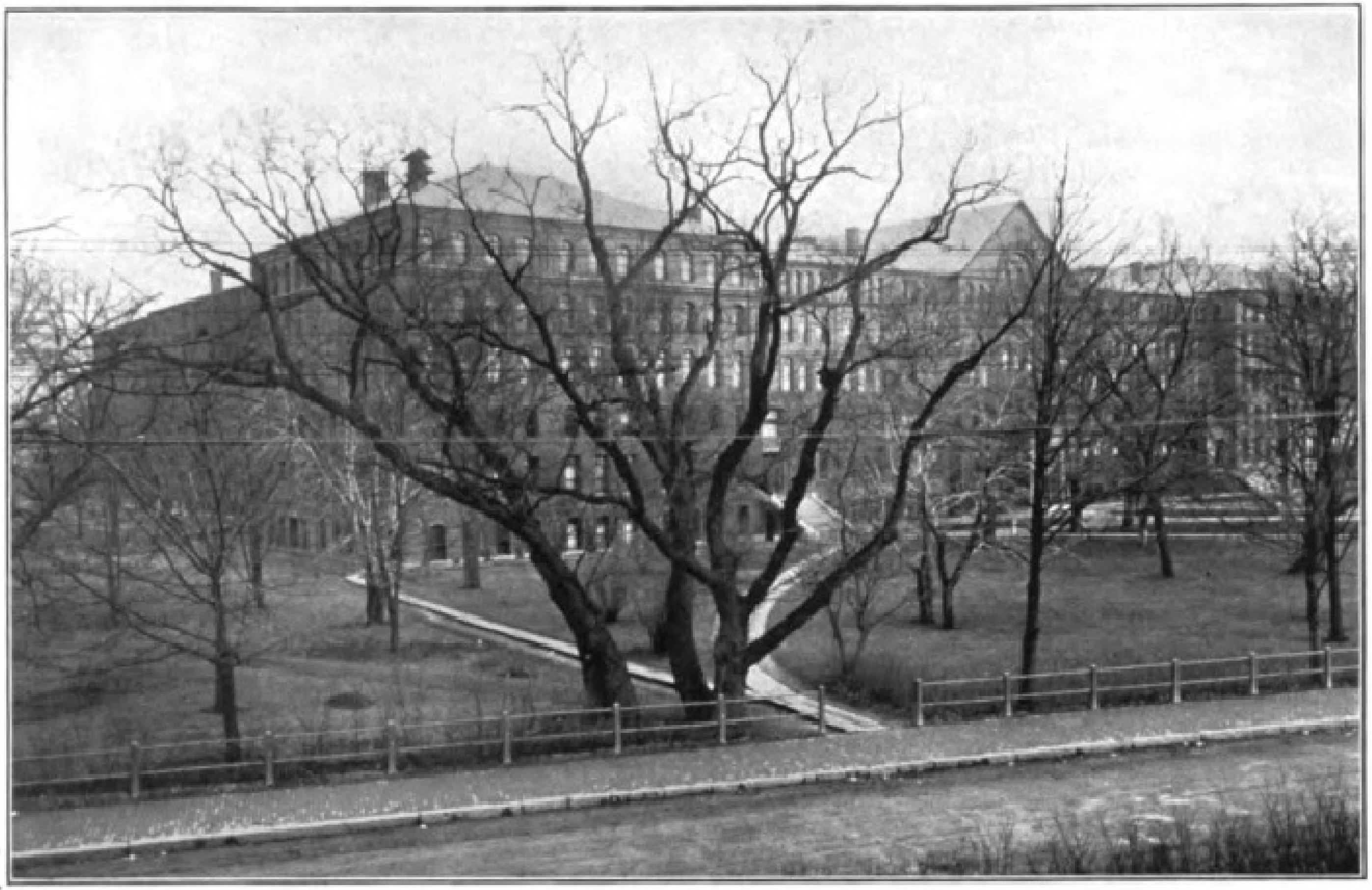


PLAN OF UNIVERSITY MUSEUM

Museum of Comparative Zoölogy. Botany, Mineralogy.
Geology. Peabody Museum of Archæology and Ethnology.

The above little plan gives an idea of the development of the building. One can gather something of its size from the fact that the façade is almost four hundred feet long and the plan one of five stories and a basement. What Agassiz accomplished within is far more remarkable than most people realize; alongside of the systematic collections, and the ample facilities for research in the convenient storing of vast collections,

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN



THE UNIVERSITY MUSEUM FROM THE NORTHWEST

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

accessible to all able to make a proper use of them, he built up a Geographical exhibit. The difficulties of such an exhibition are so well known that none of the other great museums of the world have attempted to have one. There are but two in Europe, one in Dublin, and the other in Dresden, both on a comparatively small scale. Writing on this subject in the first Museum Report after Agassiz's death, Mr. Henshaw the present Director, says: "And yet so successfully and with so true a sense of proportion did Mr. Agassiz develop the whole Museum, that the distinguished English naturalist, Wallace, stated in 1887 that as an educational institution for the public, for students, and for the special investigator, the Museum of Comparative Zoölogy was superior to the British Museum and 'probably equally in advance of every other European museum.'"

In the northwest entrance hall are two tablets that will stand till it crumbles with our civilization into dust: one to the father by the son whose filial care embodied his ideals —

LVDOVICI

AGASSIZ

PATRI — FILIVS

ALEXANDER

MDCCCLXXX

Digitized by Google Original from UNIVERSITY OF MICHIGAN

the other, after Agassiz's death, set by loving hands in the opposite wall —

IN MEMORY

OF

ALEXANDER AGASSIZ

1835–1910

OMNIA QVAE HIC VIDES MONVMENTVM

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

CHAPTER XIX

1904–1910

EASTERN PACIFIC EXPEDITION

Now that he had visited all the principal coral regions of the world, Agassiz planned to return to the more purely biological investigations, to which he had devoted his attention in his cruises on the Blake, and on the first Albatross Expedition in 1891. Wishing to inquire further into the conditions existing in the regions of the ocean far from land, he selected for his next voyage an almost unknown portion of the surface of the world, the Eastern Tropical Pacific. This vast expanse of water stretches from the South American coast to Manga Reva, or Gambier, the southeastern extension of the Paumotus. It is broken only by Easter Island, and offers a better opportunity for the study of the open ocean than anywhere else on the surface of the globe.

In 1904, he again obtained the Albatross, for the third and last time. In preparation for the voyage the equipment was thoroughly overhauled, and a Lucas sounding machine substituted for the Sigsbee, which had not proved entirely satisfactory on the 1899–1900 Expedition.

The problem of a sufficient coal supply, a most difficult one in those out-of-the-way regions, Agassiz finally solved by chartering, in Sydney, the Tagliaferro, a steamer considerably larger than the Albatross. Arrangements were made that the boat should proceed with a cargo of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

coal to Easter Island, to await the Albatross there, and after she had filled the latter's bunkers she should go to Manga Reva, and again supply the Albatross on her arrival. Agassiz hoped when he reached Callao to complete arrangements for sending a sailing vessel with coal to the Galapagos, so as to include a line to them from Easter Island. This was finally done, so that the Albatross covered the following lines — Panama to the vicinity of the Galapagos, from there to Aguja Point on the north coast of Peru. The ship then ran about southwest for some seven hundred miles, when she headed east for Callao. The next line was from Callao to Easter Island, and afterward to the Galapagos. On leaving the Galapagos the steamer made for Manga Reva, and the last line run was from there to Acapulco, making a total distance of more than thirteen thousand miles.

The Albatross was this year in command of Lieutenant Commander L. M. Garrett, who was drowned the following year in a most unusual accident. Early one evening, while the Albatross was steaming from Yokohama to San Francisco, he was alone on the poop-deck, lying in a long chair. He must have fallen asleep there, for hours later it was discovered that some sudden lurch of the ship had capsized the chair and thrown him clean through the rope rail into the sea.

The Albatross left San Francisco early in October, 1904, to join Agassiz in Panama. On board were Professor C. A. Kofoid, an assistant of the expedition, and Mr. F. M. Chamberlain, of the Fish Commission; these gentlemen made a number of hauls on the way down and collected a large amount of pelagic material.

Towards the end of October, Agassiz sailed from New York for Colon, taking with him Dr. Bigelow as assist-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

ant and Mr. Westergren as artist. The Isthmus, which had now become familiar ground to Agassiz, had lately fallen into the possession of the United States, which were just beginning to lay out the work on the canal. Panama, however, was still enjoying its pristine filth, so the party was glad to get on board the Albatross. Here Agassiz took up his abode in the new quarters he had built for himself on the spar-deck, in which he took much satisfaction. On heading to the eastward, after reaching the neighborhood of Chatham Island, the Albatross got well into the Humboldt Current. This mighty river, of which little was previously known, sweeps north off the coast of South America, and veers to the westward south of the Galapagos. Its breadth in many places cannot be much less than nine hundred miles: the western limit of its lower course appears to be about 90° W., while the southern limit of its western extension seems to lie between 10° and 15° S.

When once within the sweep of this great current, on heading in to the eastward after reaching the neighborhood of Chatham Island, the collections became extraordinarily rich. Agassiz was among the first to call attention to the fact that the great currents of the ocean teem with animal life, swept along by these mighty rivers in their journeys through the open sea. The abundance of life at the bottom, in the path of such currents, he explained by the amount of dead animal matter that fell from the surface to the bottom, and served for food to the animals living there.

Agassiz in his report of the expedition has described the richness of animal life within the limits of the Humboldt Current. Whenever the ship was in this vast body of water the tow nets were crowded and brought

Digitized by Google Original from UNIVERSITY OF MICHIGAN

up vast quantities of fishes, Salpæ, Medusæ, Crustacea, and other forms of pelagic life. On one occasion the mass of the pelagic hauls consisted entirely of small brown copepods, the contents of the nets looking like sago soup. Sometimes they came across such masses of Salpæ, Cytæis, or Cybulia as to make a thick broth of the water. In other places the surface fairly swarmed with Globigerinæ, radiolarians, and diatoms. Indeed, one characteristic of the Humboldt Current seems to be that it contains within the three hundred fathom line nearly every variation of Radiolaria and diatoms. Nor was the trawl less prolific in the material it scraped from the sea bottom, which included quantities of deep-sea fishes, Crustacea and holothurians, many of them old friends collected in the Expedition of 1891. Some interesting genera of worms were brought up and a few mollusks; compared with 1891, however, but few star-fishes and brittle stars were obtained, and fewer sea-urchins.

One interesting result of the hauls of the tow nets from three hundred fathoms to the surface was the great number of fishes caught, many of which had previously been considered true deep-sea fishes, caught only by dredging from one thousand to fifteen hundred fathoms or more. On one occasion the tow net brought up no less than twelve species of fishes in a total of nearly one hundred and fifty specimens, and on other occasions it was not uncommon to find eight or ten species and from fifty to one hundred specimens.

Whenever the plunder from a tow or trawl reached the laboratory, Agassiz's remarkable knowledge of marine fauna was a fresh source of astonishment to his assistants. He would begin a rapid enumeration of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

the catch, and jot down the results in his notebook. Nothing ever seemed to puzzle him. Not only was he deeply interested in every new and unusual creature, but he recognized everything at a glance, naming them all at first sight with amazing rapidity and almost unfailing accuracy, while he also knew where all were described. Only on the rarest occasions was he obliged to consult a reference book to confirm his opinions.

TO MRS. G. R. AGASSIZ

ON BOARD THE ALBATROSS,
NOV. 18, 1904.

A couple of days ago we finished our work to seaward of Callao and are now not more than three hundred miles from that port. I expect to dredge in a deep hole there is off that part of the coast; and if it is good ground for beasts, shall spend there two or three days scraping the bottom, and then run into Callao for coal and provisions. Thus far we have done very interesting work — not much new in the way of plunder. I seem to have got almost everything collected thus far in my 1891 Expedition in the Panamic District. Mr. Westergren is making a lot of good colored sketches, and Bigelow is drawing a lot of jelly-fishes of which we seem to have got even thus far more than in any other expedition of mine. We have been having very queer weather thus far. Soon after leaving Panama the thermometer began to drop as we went south, and when under the tropics at the Equator we got quite frozen with a temperature of 65°, all owing to our getting into the cold southern current which skirts the South American coast and strikes the Galapagos. We did not waste much time at Panama. We got there about half-past twelve Tuesday

Digitized by Google Original from UNIVERSITY OF MICHIGAN

A.M., had lunch at the hotel and dinner on board and all unpacked and tucked away in my cabin by 9, thanks to an excellent Jap boy who was got for me at San Francisco, and who is to devote himself to me during the trip. I am afraid that after three months of coddling I shall find it hard work to go back to do my own chores.

Everything thus far has worked most harmoniously and we are putting in daily a good amount of work. The Assistant sent me by the Fish Commission is a good man, as is also the Assistant I got from the University of California, Professor Kofoid, who is a very hard worker and keeps at it from morning till night. We all turn in early, breakfast at 7.30, and thus far I've not had time to read anything. I heard by cable at Panama that my collier had left Australia for Easter Island the 29th of October, so that part of the trip is safe I hope. The Captain, Garrett, is a very nice chap, always ready for work. We shall not be sorry to spend a few days at Lima while the ship is docking and coaling, and sleep in a good square bed and tramp on shore, though I cannot complain of my quarters which are most comfortable; my cabin is nine feet by twelve feet with plenty of room for a writing-table and to stow away all my clothes.

We are all wondering what has happened in the past three weeks and hope to find that the American Consul has a lot of telegraphic news of the war in the East and politics at home. I should find cables from Miss Clark telling me last news from Cambridge. We are sure to be in port the 22d or 23d, as we want, of course, to give the officers and crew a chance to celebrate Thanksgiving and let them have a good shore dinner after their

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

three weeks of sea grub. I have turned out this time an excellent sailor and have been most comfortable all the way from New York here.

We 've got quite a menagerie on board, — a monkey, a parrot, three cats, a puppy, and a huge goat, which in 1899 was given the Albatross by one of the chiefs at the Marquesas. He brought us then about a dozen kids, all most diminutive. We kept two, ate all the others. Of the two, one was carried off the deck by a heavy sea off the Gilbert Islands, the other is now on board, a huge hairy and horny beast which feeds mainly on shavings and blotting-paper, and is full of mischief. The goat was a great friend of the former executive officer who occupied my room, so "Billy" comes and sees me every morning when I am having coffee and toast to see what he can pick up.

After waiting a few days in Callao, Agassiz started for Easter Island on December 3, without having been able to clean the ship's bottom, for a vessel already in dock proved to be so badly injured that she seemed likely to remain there indefinitely.

The line from Callao to Easter Island first disclosed the fact that west and south of the Humboldt Current, a vast tract of desert sea stretches uninterruptedly over a huge area of the Pacific Ocean. Until about 90° W. the hauls continued much as they had been on the previous line, but after this as the ship left the current matters changed rapidly, and the expedition found itself in a region almost barren of pelagic fauna, while the trawl brought up from the bottom nothing but quantities of manganese nodules, sharks' teeth, and whales' ear-bones.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

As this condition, which Agassiz had previously suspected, became apparent, he took a greater and greater interest in the work, which was continued with unfailing regularity, to develop the extent of the desert. As each successive haul of the trawl was swung on board he would, after examining its contents of mud and nodules, exclaim with a smile, "Not a thing," and while in this region was most pleased when he got least.

These desert tracts of the ocean's bottom can be accounted for by the fact that they exist in regions where there are no great currents to transport life over the upper layers of the sea. As there is little or no life on the surface, no food falls to the bottom, and there is nothing to support life there. In such places for various reasons there is but little accumulation of any deposit, and on this account the teeth of the huge Tertiary sharks, and the ear-bones of the whales, which must once have frequented these waters in large numbers, have not been covered up. Other portions of the skeletons of these animals are not found because they are more easily dissolved, and have disappeared.

While in this desert region, it seemed impossible to avoid manganese nodules. Sometimes the trawl would come up so heavily loaded with these concretions, which looked much like irregular potatoes, that as the bag left the water, after a few labored turns of the engine, the net would give way, and only its remnants would be swung on deck. Later in the voyage Mr. Chamberlain contrived a support by which this danger was very much lessened.

Murray, the authority on such matters, accounts for these nodules somewhat as follows. He considers them secondary formations derived from the decomposition of

Digitized by Google Original from UNIVERSITY OF MICHIGAN

volcanic rocks and minerals, principally pumice, the products of both aërial and submarine eruptions. In desert regions, where little else accumulates on the bottom, these volcanic products are exposed for a long time to the action of sea-water and thus undergo alteration. The manganese contained in them is converted into bicarbonate of manganese, which is deposited as manganese dioxide upon coming into contact with the overlying water. The deposition usually takes place around a nucleus, which may be a shark's tooth, an ear-bone of a whale, or a decomposing fragment of volcanic glass, though in some cases no nucleus can be detected.

As the Albatross neared Easter Island, Agassiz became very anxious about meeting his collier, supposed to be approaching this isolated spot from the other end of the world. Any failure on her part would, indeed, have proved a very serious matter, for there is no communication with the island except about once a year, when a Chilian man-of-war calls there. As the ship approached Cook Bay, every one was eagerly looking ahead. On rounding the promontory, not only did the collier come into view, but to their intense surprise a Chilian man-of-war, whose captain Agassiz suspected had somehow got wind of the expedition and turned up there to see what was going on.

TO MRS. G. R. AGASSIZ

On Board the Albatross,
Easter Island, Dec. 17, 1904.

Little did I think that on my 69th birthday I should be writing you from such an out-of-the-way place! We arrived here the 15th after an excellent trip from Callao; the Captain of the collier was on board almost before

Digitized by Google Original from UNIVERSITY OF MICHIGAN

we dropped anchor, and we arranged to coal at La Peyrouse Bay, on the south side of the island, where the swell interferes less with coaling alongside another steamer. By 9 o'clock we were anchored there and at work in full blast. While we were coaling we went on shore to collect plants and insects and to examine some of the platforms on which the natives of former days used to erect their stone images — a more desolate-looking place I don't know except the great lava flows of the Sandwich Islands. But this island is perhaps worse for its weak attempts to grow grass on which the owners try to raise sheep and cattle. The walking about all day was most tiresome; we were glad, indeed, to get on board again where you could put your foot down without fear of twisting your ankle in a hole between two pieces of rock.

To-day we started off early to see the quarries where the stone images are made. We got some nice little ponies, most sure-footed beasts, and a great improvement over walking. The stone images are found in all stages of finish in the interior slopes of a volcano at the east end of the island, Rana Koroka, as well as at those of the outer face. They are cut out of a comparatively soft volcanic ash which hardens with exposure. They cut all round them and when free stand them up on end to finish them, and then carry or slide them by main force to the platforms which line the seacoast of the island.

One of the finest of all the platforms is near the crater, but the images are no longer on their base. They are all flat, lying at the back of the platform. They must have been knocked down by an earthquake or some cataclysm, as it looks as if the whole work on the island was suddenly put a stop to.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN





EASTER ISLAND IMAGES, ABANDONED ON THE MOUNTAIN SLOPES

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

I am sending this by a Chile man-of-war we found here; she leaves to-morrow for Valparaiso, twenty days' passage. As the Chilians only send the vessel once a year, it was quite a hit to enable me to give signs of life.

During the five days that the Albatross lay off Easter Island, Agassiz was as eager in the study of the mysterious images and the remnant of the native population as in collecting the fauna and flora of this isolated oceanic island.

The origin of these colossal statues is an unsolved mystery, though it seemed probable to Agassiz that the immediate ancestors of the present inhabitants were the sculptors of the images. Some of the natives pretend that the carvers were their great-great-grandfathers. If so, the unambitious and indolent natives must be a great contrast to their sturdy and industrious ancestors, who somehow accomplished the Herculean, if somewhat misguided, task of encircling the island with a series of massive platforms surmounted by these rude Goliaths.

He found that the natives had long abandoned the houses of their ancestors, built of stone slabs against the hillside, for steep-roofed thatched huts. These in their turn had of late years been replaced by rude hovels of rough boards, built under the direction of a Danish carpenter, from a shipload of lumber wrecked on the island. A number of families often occupied one of these shanties, where at night men, women, and children would lie down like dogs in a kennel, with about the same ideas of the comforts of life.

Agassiz concluded that the population of this island in 1860, shortly before a large number of them were

Digitized by Google Original from UNIVERSITY OF MICHIGAN

kidnapped by the Peruvians, must have been about three thousand. Since then the inhabitants have been afflicted with that mysterious blight which settles on all Pacific Islanders at the slightest contact with civilization. Ten years later the population was reduced to nine hundred; and at the time of his visit there were less than one hundred and fifty inhabitants.

The largest indigenous animal on the island proved to be a small lizard, but this did not dampen the ardor of the collectors, who greedily gathered whatever they could lay their hands on in the way of flies, lizards, earthworms, and cockroaches, much to the amusement of the simple-minded natives. Doubtless they would have appreciated the comment of a stage-driver in the White Mountains, who remarked of the elder Agassiz and a party of his assistants, — "They said they was 'naturals,' and I should think they was!"

On leaving Easter Island the ship ran into a two days' blow, the first gale of the trip, and although the Albatross was tossed about in the liveliest way, Agassiz was pleasantly surprised to find that on this occasion he was not seasick. Any one who has experienced the distressing effects of even a short period of seasickness will realize his enthusiasm for his explorations by the fact that he persisted so ardently in this work in the face of his great susceptibility to this malady.

Until they again ran into the Humboldt Current in about 12° S. latitude, the barren condition of the ocean continued; north of this they once more found the same richness of life as in other portions of the current. This lasted till they reached Chatham Island in the Galapagos. Here they found the schooner with their coal waiting for them in Wreck Bay, which she

Digitized by Google Original from UNIVERSITY OF MICHIGAN

had reached from Callao six days previously. It was the height of the dry season, and the great gray slopes of the island, covered with dry bushes and shrubs, were quite as uninviting in appearance as Darwin described them. When the Albatross visited the island in 1891, during the wet season, everything was green, and Agassiz, as previously noted, was much struck with its luxuriant appearance as contrasted with Darwin's impression of its general desolation.

On shore the party found the convict settlement temporarily abandoned, and the island held by a small Ecuadorian garrison. For Mr. Cobos, the former lessee of the island, who in 1891 was farming his plantation, had been killed some years previously in an insurrection of the convicts hired from the Government.

On leaving Chatham Island for Manga Reva, the ship again ran into the desert region at about 15° S., and remained in it until a short distance from Manga Reva. On reaching the port of Rikitea it became evident that if the ship were ever to reach Acapulco with the coal she could carry from Manga Reva, something must be done to clean her bottom, which had become excessively dirty from long exposure to tropical seas. Agassiz, remembering that pearl-divers were half-amphibians, solved the problem by distributing wire brushes to a number of natives, who succeeded in diving under the ship and scrubbing her clean from stem to stern.

While this process was going on and the ship was coaling, Agassiz spent his time exploring the Gambier Islands, of which Manga Reva is the largest. Darwin, from an examination of the charts, had called attention to the similarity of this archipelago to Truk in the Carolines. Agassiz, after having examined them both, was

Digitized by Google Original from UNIVERSITY OF MICHIGAN

struck by the same likeness. He considered that the Gambier Islands represented what was left from the erosion of a much larger island with a number of volcanic craters. It appeared to him to be an intermediate state, of wasting away from atmospheric agencies, between Truk and such a barrier-reef island as Bora Bora in the Society Islands.

On February 4 the Albatross, her deck loaded with coal, left the archipelago for Acapulco, some three thousand three hundred miles to the eastward. Agassiz had calculated that by carefully husbanding his coal he could manage to visit Clipperton Island, as well as continue his sounding and dredging operations. All went well for some days, but when still several hundred miles within what was supposed to be the region of southeast trades, the ship unexpectedly struck a strong and continuous head wind. The visit to Clipperton Island was given up, and all work abandoned except the morning's soundings. As the head winds continued with increased violence, it became evident that every ton of coal would have to be watched to enable the ship to reach port. During the last few days the situation became so extremely critical that Agassiz and the Captain consulted as to the possibility of reaching some island to leeward, under what little sail they were able to spread. As the Albatross under these conditions would have behaved much like a raft propelled by a pocket handkerchief, the merest landlubber can, from a glance at the chart, easily imagine the feelings of the leader of the expedition and the commander of the ship. When, at length, with only a few hours' coal in the bunkers, the chain rattled through the hawse-pipe in Acapulco Harbor, it lifted a great weight from two very anxious men, who

Digitized by Google Original from UNIVERSITY OF MICHIGAN

during the last few days must have more than once thought of such conditions as are pictured in the "Ancient Mariner."

On the way to San Diego all hands were busy putting the collections in order and packing them for shipment; but though Agassiz and his assistants worked from daylight till dark, the work was not half finished when they reached port. Here the expedition disbanded, Dr. Bigelow being left to superintend the packing and shipping of the collections, and attend to the hundred and one loose ends that are the necessary accompaniment of so long an expedition. Part of the collections was sent to Washington and part to Cambridge, whence they were distributed for study to specialists in all parts of the scientific world. The collections sent to Cambridge filled half a freight car.

In writing of Agassiz some years later, Professor Kofoid says: "Throughout the whole Expedition, and even more so as I now look back at it, I was impressed by the fact that he viewed the whole in a large way; although the whole was planned and executed with great attention to the minutest details, it was nevertheless carried out with certain larger ends definitely in view, and these were never for an instant lost sight of amidst the mass of detail that inevitably envelops such an enterprise. His work revealed a master mind, great in its comprehensive conception of the problems of the sea, and its executive efficiency."

One of Agassiz's characteristic traits was the care with which he planned for future engagements at the other end of the earth, and the punctuality with which he met them. An extract, written from the Galapagos to his son in Santa Barbara, is a good illustration of this quality.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

"As far as I can guess from the past dispatch of the work and speed of the Albatross, we are due at Manga Reva the last of January and should arrive at Acapulco the last day of February and at San Diego the 12th of March and at Santa Barbara two or three days later. I must be back in Cambridge the 26th or 27th of March to clear the decks and get ready for the Washington meeting of the Academy, the 17th of April.[1] So that when I telegraph you my movements from Acapulco, engage for me a stateroom or a compartment by the Santa Fé to Chicago for the *22d of March*; if you can't get via Santa Fé, get the same accommodation via Rock Island to Chicago. If that does not work, telegraph to San Francisco for the same via Central and Union Pacific. I take it Max will be there and will probably share my quarters."

As usual, Agassiz had returned on time to the day, after having explored one of the least known portions of the earth's surface. His short journey in the cars to Santa Barbara was an amusing contrast, for the local train was delayed for three days in a washout.

This was the last of Agassiz's expeditions devoted to zoölogical work. His cruises in the Blake had made the Gulf of Mexico, the Caribbean Sea, and certain portions of the Atlantic, as well known oceanographically as any regions of the world. In his first Albatross Expedition he had extended his investigations to the regions to the westward of Panama, and in this last voyage he had explored a vast extent of unknown ocean and discovered a huge desert area.

One of the chief ultimate objects of his oceanic inves-

[1] To preside as President of the National Academy.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

tigations was the amount of variation from type that may be expected in a given period of geological time, as illustrated by the difference in the fauna on the two sides of the Isthmus of Panama since the days when the Caribbean was virtually a bay of the Pacific. The reports of the specialists on his material collected on both sides of the Isthmus were to be made with this end in view; while the preliminary geological studies, carried on in connection with his study of West Indian coral reefs, had been extended under his direction by Hill and others, so that he felt that he had an approximate idea of the period.

When he was chosen president of the International Zoölogical Congress of 1907, he first selected this question as the subject of his presidential address. But feeling that he had not yet received the reports of a sufficient number of his collaborators to make as complete a study of the subject as he desired, he finally abandoned it in favor of a summary of American oceanography.

It is one of the tragedies of a full life that so much must be left unfinished. His "Panamic Report," so long looked forward to, was never written. Thus the greatest quantitative study of the progress of evolution ever attempted was left without the final touch of the master hand.

The following winter of 1905–06 he spent on the Nile, where he had passed a winter just twenty years before. At Luxor he was much interested in visiting, in the Valley of the Kings, the excavations of his Newport neighbor, Mr. Theodore Davis. The archæological treasures which that gentleman has unearthed are now well known to every one who has heard anything of Egypt, and it may be worth noting that his first interest

Digitized by Google Original from UNIVERSITY OF MICHIGAN

in the land of the Pharaohs was excited by a little book by Mr. Martin Brimmer, lent him by Agassiz.

On his way through France, Agassiz stopped at Monte Carlo to see the Prince of Monaco, and the boat the Prince was using for his oceanographic work, to which he had been devoting for a number of years a large part of his royalties from the gambling-tables. Thus those who throw their money away at the Casino can have the consolation of knowing that they are really supporting scientific research.

TO MRS. G. R. AGASSIZ

PARIS, March 3, 1906.

I am glad to be in Paris again and will try and settle down and begin to work on the address I have to give in August, 1907, as President of the Zoölogical Congress, which meets in Boston in August. I tried hard to get out of it, but could not manage it. I hate to give that sort of thing; one has to spend no end of time in saying nothing of any value and yet accuracy is needed and requires endless quotations and looking up people's views. I never but once delivered such an address, to the American Association for the Advancement of Science, ever so long ago at Cambridge, and if I remember rightly it cost me six months of hard work. I infinitely prefer to write a large monograph or a report on an expedition, where there is something definite, and when you have done, something of value remains. Though it is true that for the short time of a month or so the address calls for a lot of notoriety and discussions, neither of which is to my taste. I tried while loafing at Cairo to make a start, but could not get going. It seemed hopeless. I hope to succeed better while here and in London. I am here for

Digitized by Google Original from UNIVERSITY OF MICHIGAN

a couple of weeks and the same in London, to sail the 28th by the Kron Prinz Wilhelm, reaching New York the 3d of April. Max and I both wish we had kept on in our steamer from Naples to Marseilles and gone back to Monte Carlo. The Italian railroads are simply infernal and filthy and crowded to death. Being Government railroads, complaints are of course useless, and yet that is what Theodore the First wants to do. I should like to condemn him to a week of travel there — he 'd change his views.

We had an excellent sight of the lava flow of Vesuvius; it was really very fine at night to see the great river of red lava flowing down the slope and occasionally reinforced by an explosion and flow from the crater. It was quite cold in Italy; the snow was halfway down Vesuvius, and going north of Rome came to within a few hundred feet of the plain from the summits. The few days we had at Monte Carlo were beautiful, and I greatly enjoyed seeing the Riviera again. I dropped into the Casino, and a more disgusting sight I can't imagine, to see the old men and women with their claws reaching out for the little they make, while the bank is raking it in, and young and old sitting there all day long. I should think a couple of visits would cure any gambler. There must have been twelve to fifteen hundred people in the Casino at a time and a flood going in and out.

I lunched with the Prince, where there were a lot of people I did not know, but found the members of his household whom I had met in Paris and the Captain of his yacht, who was an old acquaintance. As soon as we could get away he took me to see his Oceanic Museum; it is a large and very handsome building to be finished

Digitized by Google Original from UNIVERSITY OF MICHIGAN

in two years, where he proposes to put on exhibition everything pertaining to marine life, etc., and to have laboratories for studying the ocean in all its aspects. We then went on board his yacht, the Princesse Alice, a boat of somewhat larger size than the Albatross, about two hundred tons more. She is a splendid boat and admirably equipped for all the kind of work I have been doing. Her only defect is she is not a twin screw and that too much space has been taken for the Prince's quarters and servants, at the cost of coal space and laboratory quarters. But she is just the kind of vessel I ought to have built in '79 when I came back from my second Blake Expedition. I think it would have paid me to have been absolutely independent for twenty-five years and not to have been obliged to use the Albatross, though I had her on admirable terms, and to charter tramps and keep transferring my equipment from one boat to another. However, I've done my share of work of that kind and somebody can go ahead now. The Prince had arranged to make a short cruise with me to Marseilles and let me see the working of the ship; unfortunately he had to give it up, as part of his necessary equipment had not got on board and was side-tracked somewhere on the way.

Feeling that he would like to visit the West Indies again, Agassiz chartered the steam yacht Virginia for the winter of 1907. After his study of coral reefs in the Indian Ocean and the Pacific, he wished to see something more of this region and to check some of the geological work that had been done for him there. Two of his sons, a daughter-in-law, and the wife of one of his assistants were included in the party, so that the expedi-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

tion resolved itself into the combination of scientific review and yachting cruise.

The yacht's track is not shown on the chart, for it covers much the same ground as the second cruise of the Blake: along the Windward Islands to Grenada and back to the south of Porto Rico and Haiti, around the east end of Cuba and through the Old Bahama Channel.

TO MRS. LOUIS AGASSIZ

On Board the Virginia,
Roseau, Dominica, March 5, 1907.

I have not given any signs of life for quite a while, though I have cabled from every island to Dolph and I presume you heard of my progress. We have had excellent passages thus far, though the boat being small she is pretty brisk in her movements, and we have all at different times succumbed to her motion. I had forgotten how beautiful the islands were, for when I was here in '78 the interest in the deep-sea dredging was my first care and land interests were relegated to the rear. Now it is the reverse. Some of the days we spent going round Montserrat, St. Kitt's, and specially Guadeloupe and Dominica were within reach of beautiful landscape, ever-changing mountain scenes and superb vegetation. Geologically the country is very interesting, and I am checking to a great extent the work of one of my assistants who has been here in past years, and just sent in his Report in time for me to read it before starting. A Mr. Spencer has also written a good deal on the subject, but he had preconceived ideas which warped his views of all he looked at. I have never been on an expedition in such a princely way. Comfort does not express the state of things existing on the Virginia. There is everything

Digitized by Google Original from UNIVERSITY OF MICHIGAN

you can think of on board for comfort, servants without end, an excellent stewardess, a capital head steward who is indefatigable, a chef whose cooking is simply first-class. The Captain, officers, and men are all old hands on board, most of them have been on board the Virginia since she was built, and take the greatest possible interest in all that is going on. I am greatly disappointed at the poverty of the towing. I expected full nets in all the passages, instead of which I find nothing or almost nothing. I cannot explain it as yet, but hope on the way home to get some clue to such a queer state of things. The assistants and machinery are all working well.

About this time a number of events combined to sap the vigor of Agassiz's old age. Calumet had recently acquired control of a number of neighboring mines. A small coterie of the minority stockholders of an adjacent property, with whom there had been a feud since the early days of Calumet, attempted by every trick known to the law to exclude the majority from the management. Agassiz was ultimately victorious, but the attack was so viciously ill-natured and so gratuitously insulting that it exasperated, distressed, and depressed him to an extent that would have been scarcely possible had he possessed the buoyancy of a younger man.

When Mr. Schuyler was killed in a distressing railway accident in the south, Agassiz was so broken by the shock that he felt unequal to going to the funeral, and sent one of his sons to represent him. He and Mr. Philip Schuyler had been the warmest of friends for upwards of fifty years. It was a very unusual and touching friendship; the admiration of the genial man of the world for the learned man of science was only equaled

Digitized by Google Original from UNIVERSITY OF MICHIGAN

by Agassiz's attachment and affection for Mr. Schuyler. During the latter's frequent visits to Cambridge they would spend days together at the Museum in the most complete sympathy and understanding; Agassiz at work on whatever he had on hand, and Mr. Schuyler quietly reading.

In the early summer of 1907, his stepmother died after a trying invalidism of several years. As she was tenderly laid beside the great boulder from the glacier of the Aar that, under the shade of Swiss pines, marks the grave of her husband, one felt that Agassiz had suddenly become an old man; the last threads binding him to the past had snapped.

A few words from a letter written that summer may suggest better than anything else the very unusual place which Mrs. Agassiz held in her stepson's life.

"I can't realize that when I go back to Boston I am not going to see mother again. I do not associate her in any way with Newport, as she always clung to Nahant; but when Max and I go back to Cambridge, the Quincy Street house will seem very empty. Fortunately I am well and can look forward to work to fill the gap which has been made. But the associations of nearly thirty-five years are not easily changed, and our relations were so peculiar that I don't know what to style them. She was my mother, my sister, my companion and friend, all in one. She carried her unspoken sorrow with a brave front, and was only too glad to be at last released. The like of her we shall not see again. From the time that I first saw her at Mr. Felton's house as Miss Cary, and I only a small boy of thirteen, there never was a word of disagreement; she belonged to me and I to

Digitized by Google Original from UNIVERSITY OF MICHIGAN

her; it could not have been otherwise: she learned to know me through and through and placed in me the most unbounded confidence, and entrusted me with the keeping of her sorrows."

The winter of 1908 found Agassiz headed for East Africa in search of warm weather.

TO WOLCOTT GIBBS

CAMBRIDGE, Dec. 25, 1907.

I am off again to-morrow, sailing Friday per Baltic for Liverpool, to stop a few days in London and Paris, and thence to Marseilles, where I sail the 18th January for Mombasa, the terminus of the Uganda Railroad leading to Victoria Nyanza. I am taking with me Max and Woodworth. This is a lazy loafing trip merely to get into a good warm region; no work except to keep my eyes open to see the many tribes of darkies which occupy that part of East Africa. Besides that the scenery is fine and game in way of elephants, giraffes, and antelopes, to say nothing of hippopotami and rhinoceros plenty; lions have a way of picking passengers out of their sleeping-cars: otherwise everything is most comfortable. I expect to be back early in April in time for the Academy meeting. I see the American Philosophical Society is still insisting on holding its annual meeting at the same time as the Academy, which will cut out a good many members. It is too bad there should be this antagonism and duplication of meetings and attempt on the part of Philadelphia to cut out the Academy by superior food attractions.

He appears to have been fascinated by the presence of the herds of wild animals which seem to have been

Digitized by Google Original from UNIVERSITY OF MICHIGAN

plentiful in the neighborhood of the Mombasa and Lake Nyanza Railroad, and his letters are full of descriptions of them. "The presence of these large mammals gives to the scenery a decidedly Tertiary look, and one can readily reconstruct, if not the mammalian and reptilian fauna, even of an earlier period, at any rate build up the conditions under which they lived as contrasted to the Tertiary period. The areas which still contain these huge monsters of the present day are becoming more and more restricted, and soon our imagination alone will be left to draw upon and build up these prehistoric times."

He used to tell of some amusing observations he made of the giraffes. This animal is supposed to be a fine example of the survival of the fittest, the fittest in this case being those who possess the longest necks and front legs, which enable them more readily to reach the high boughs upon which they are supposed to feed. He was interested to notice that all the giraffes he saw were feeding upon low bushes!

Of his trip in the little steamer that plies around the shores of Lake Nyanza he writes: "Equally interesting are the natives but little removed from utter barbarism, living huddled in reed huts and dressed in shields, spears, and necklaces. But they are fine specimens of humanity, in great contrast to the wretched type of West African Congo negro, who has been imported to the United States during the days of slavery. The natives are thickly settled around the shore of Lake Nyanza. Their villages are clean, well built, and orderly, and in our cruise around the Lake we enjoyed nothing more than our visit to these primitive settlements. We made a few hauls of the tow net, but did not get anything of importance."

Digitized by Google Original from UNIVERSITY OF MICHIGAN

He escaped the New England winter of 1908–09 by a visit to southern Italy. While in Naples he tripped on a curbstone, fell headlong on his face, and knocked out his front teeth. It was a painful accident, but what appears to have bothered him most was that he should have spent his life in roaming about safely to the ends of the earth, only to meet disaster on the sidewalk of a European city.

He had intended to spend the winter of 1909–10 in wandering about Java and the East Indies. Ever ready for new work, he had also meant to look about with a view to seeing what arrangements he could make for chartering a steamer for an exploration in those regions another year. But that fall a persistent and severe attack of the old trouble with his leg warned him that it was wiser to keep within touch of doctors, and he decided to pass another winter in Egypt.

He appeared to enjoy his winter on the Nile, and to be in his usual health and in good spirits. It was not till afterwards that his son Maximilian realized how often he had found him asleep; still his last few months seem to have been quiet and happy ones.

On the way home there was some question of passing around Paris on account of the recent floods which had been causing such distress in that city.

TO MRS. G. R. AGASSIZ

HOTEL ATHÉNÉE, PARIS,
March 10, 1910.

As you see, after all we got to Paris. On further inquiry I found the doctors thought Paris cleaner than it had ever been, and that with all the disinfection that had been going on it was really as safe as at any time

Digitized by Google Original from UNIVERSITY OF MICHIGAN

in the winter. So we came and are in our old quarters, somewhat in a mess, as the manager is taking advantage of the boycott against Paris by strangers to revamp the whole house. I have seen a few of my Paris friends; those at the Jardin des Plantes fared badly, and the menagerie worse than its keepers. They lost but one beast, one old lady giraffe who had seen her best days. The basement of the buildings where the duplicates are kept fared badly, and I fancy those collections suffered greatly. The great wine-sheds along the Seine were swept clear of thousands of hogsheads of wine that have gone down the Seine to —— ? It is even now quite a sight to see the Seine rush against the arches of the bridges; a few only of them are fully opened. They must have been well built to stand the enormous pressure thrown against them — not one was carried away. But the damage done to Paris, and especially to the suburbs, is stupendous. It is a catastrophe. All the small workmen who owned their houses in the banlieux, who came to Paris every day to work, are cleaned out, their houses and all cleared away, ruined from one day to the next, nothing left after having provided a home and for the future of their families. It is amazing how the people have recovered their bearings. Everything goes on as usual; all the theatres, cafés, etc., are opened in full blast as usual. The recuperative capacity of the French is amazing, — the Franco-German war forty years ago, and then such a calamity as this flood on the top. They ought to be crushed, but they rise to the occasion and get ready for the daily work, which, after all, has carried many a man over calamities which seemed unbearable.

We had an excellent passage to Naples, stopped there

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

a couple of days — on to Rome ditto, and have engaged our passage for New York on the Adriatic to sail the 23d.

I expect to be a few days in Cambridge before the meeting of the Academy in Washington the 19th of April, then back to Quincy Street, then to Calumet early in May, and then to Newport so as to be there last part of May ready for business. What are your plans? Love to George.

On his way home he passed through London, where he dined with Murray and a number of his scientific colleagues just before sailing. He took passage in the Adriatic on March 23; a few days out he spent the evening chatting in the smoking-room with a few friends, and went to bed apparently cheerful and contented. Sometime early the next morning, on Easter Sunday, March 27, he died quietly in his sleep. Fittingly upon the ocean, in whose mysteries he had so deeply delved, his mother Nature whispered to him her great secret, and led him peacefully and painlessly into the unknown. He lies beside the wife of his youth, whom he had buried thirty-six years before in Forest Hills.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

ENVOI

HENRY ADAMS TO H. L. HIGGINSON

WASHINGTON, Apl. 2, 1910.

I wish I were there to show what respect I could for Alex. If I showed all I felt, it would be worth while to go far. He was the best we ever produced, and the only one of our generation whom I would have liked to envy. When I look back on our sixty years of life, and think of our millions of contemporaries, I am pacified when the figure of Alex occurs to me, and I feel almost reconciled to my own existence. We did one first-rate work when we produced him, and I do not know that, thus far, any other country has done better. I feel as though our lives had become suddenly poor — almost as though our generation were bankrupt by his loss. He stood so high above any one else in my horizon that I can no longer see a landmark now that he is gone. To any one else except you I should have to explain all this feeling, but you know how true and natural it is and I can leave it so.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

INDEX

Abbot, E. H., 19.
Acalephs, 47, 116, 273, 345.
Acapulco, 259–61.
Adams, Henry, 447.
Adams, J. Q., 241.
Africa, East, 442–43.
Africa, north coast, 232–33.
Africa, South, 346–47.
Agassiz, Alexander, birth, 6; life at Neuchâtel, 6–8; at Freiburg, 9–13; leaves for America, 13; arrival in America, 14; goes to Cambridge High School, 15; life at Cambridge, 15–18; visits Charleston, 18; college life, 19–23; Scientific School, 23; teaches in his father's school, 23–24; Coast Survey assistant in Cal., 25–27; appointed agent of Museum, 28; marriage, 28; life at Museum, 32–44; early zoölogical research, 44; summer work at Nahant, 45; embryology of Echinoderms, 45–46; study of Annelids, 46–47; of Acalephs, 47; first views of evolution, 48–52; manages coal mines in Penn., 53; visits Calumet, 57; opinion of Calumet, 58–60; sent to take charge of Calumet, 61; life at Calumet, 62–85; later development of Calumet, 86–89; resumes scientific work at Museum, 91; study of beaver, 94–96; illness, 97; visit to Europe, 97–114; work on "Revision," 114; rents "Shady Hill," 115; study of Tornaria, 115; embryology of jelly-fish, 116; visits Challenger at Halifax, 121; publication of the "Revision of the Echini," 122; on evolution, 122–23; death of his father and wife, 124; takes charge of the Museum, 128–29; continues school at Penikese, 129–31; visits Chile and Peru, 131–41; exploration of Lake Titicaca, 142–49; collects South American antiquities, 149; selects Newport as best place for marine studies, and builds a house, 151; his dislike of automobiles, 152–53; the Newport Laboratory, 153–56; studies in embryology, 156; of flounders, 156–57; helps sort the Challenger collections, 157–58; the Challenger Echini, 158–61; on evolution, 162–64; early interest in oceanography, 165, natural aptitude for, 167; liability to seasickness, 167; broader aspects of work, 168; invited to take charge of Blake, 169; adopts wire rope for dredging and other improvements, 169–71; first cruise of Blake, 172–79; on wire rope, 173–75; second cruise of Blake, 178–82; third cruise of Blake, 183–85; distribution of collections, 185; Gulf Stream, 185–86; Panamic studies, 186; on survival of Archaic types, 186–87; on the depths of the ocean, 188–89; unable to winter in New England, 191; mining ventures, 191–92; visit to ruins of Yucatan, 194–203; Mexico, 203–04; visits India, 208–10; visits Hawaiian Islands, 213–16; on early Americans, 216–17; offered charge of Coast Survey, 219–20; Egypt and Eastern Med., 221–23; fires in Calumet, 225–26; honorary degree at Cambridge, Eng., 227; Cor. memb. of French Academy of Sc., 227; winter in northern Africa, 232–33; his development of Museum, 235–37; other University interests, 237–38; in re undergraduate education, 238–40; resigns from Corporation, 241; First Albatross Expedition, 244–63; bathymetrical range, 263–66; Panamic studies, 266–68; Japan, 269–71; Calamocrinus, 272; young fishes and jelly-fish, 273; scientific correspondence, 273; Florida reefs, 277–78; Coral theories, 279; Tortugas, 280–82; to Darwin on coral reefs, 284–86; Hawaiian reefs, 286–87; Bahamas, 288–95, coral formations, 296–98; Bermudas, 300, structure of, 301–05; Florida reefs, 306–09; Great Barrier Reef, 311–19, formation, 319–21; Mexico, 322; the Fijis, 324–35; Hawaii, 335, reefs of, 335–36; for-

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

mation of Fijis, 336–43; Funafuti bore, 343–44; South Africa, 346–47; Second Albatross Expedition, 348–73; Tropical Pacific reefs, 373–79; Europe, 381; portrait by Lefebvre, 381; Maldives, 383–95, formation, 389–92; popular book on coral reefs, 395–96; life at Newport, 397–98; contributions to Museum and Harvard University, 399; Calumet, 402; underground temperatures, 402–03; Europe, 405–08; Royal Society lecture on Coral Reefs, 408–09; "Hawaiian and other Pacific Echini" in collaboration with Prof. H. L. Clark, 409; Colobocentrotus, 409; methods of work, 409; offered charge of Carnegie Institute Exp., 410; Panamic Echini, 411; elected Foreign Associate of the French Academy of Science, 412; other scientific honors, 412–13; later relations with Museum, 414–18; Eastern Pacific Expedition, 419–33; Panamic Report, 435; Egypt, 435–36; Monaco, 436, 437–38; Virginia Exp., 438–40; East Africa, 442–43; accident in Naples, 444; Egypt, 444; death, 446.
Agassiz, Anna Russell; marriage, 28; 68, 73, 98, 100, 102, 105, 113, 119; death, 124.
Agassiz, Cécile Braun, 3, 4, 9, 10, 12.
Agassiz, Elizabeth C.; marriage, 15; 16, 23, 44, 100, 103, 106, 107, 110, 113, 125, 126, 132, 138, 142, 151, 194, 197, 200, 204, 300, 382, 403; death, 441–42.
Agassiz, Louis, 2, 3, 4, 5, 6, 7, 8, 9, 14, 15, 16, 18, 23, 28, 31, 32, 36, 97, 119; death, 124; 128, 129, 277, 412, 417, 430.
Agassiz, L. B. R., 1.
Agassiz, Rose Mayor, 2.
Albatross, the, 244; First Expedition, 244–63; Second Expedition, 348–73; Third Expedition, 419–33.
Alexander, A. B., 348.
Ampère, A. M., 17.
Amra, the, 383, 385.
Anderson, John, 129, 131.
Andrews, E. C., 341.
Arago, D. F. J., 185.
Archæology, American, 131, 141, 143, 144, 145, 146, 149, 199, 200, 202, 216, 217.
Archaic types, 186–87.
Argyll, Duke of, 227, 228.
Atacama desert, 137–38.
Athens, 221–22.

Bache, A. D., 25.
Baer, Karl von, 163.
Bahamas, 288–95; formation, 297–98.
Bandai San, 269, 270–71.
Barlow, F. C., 19.
Bartlett, J. R., 178, 183, 186.
Bathymetrical range, 184–85, 252, 263–66, 299.
Bavois, 1.
Bazaine, A. C., 111.
Beavers, 94–96.
Belknap, G. E., 243.
Bell, F. J., 236.
Bermudas, 301–05.
Bibb, the, 166, 181.
Bigelow, H. B., 384, 420, 423, 433.
Bismarck, Prince, 109.
Blake, the; equipment, 169–72; first cruise, 172–78; second cruise, 178–82; third cruise, 183–85; 188.
Bololo, 328, 345.
Bonney, T. G., 228.
Booth, Edwin, 17.
Bora Bora, 363; formation and model of, 377; 432.
Bowers, G. M., 348.
Braun, Alexander, 3, 9, 163.
Braun, Carl, 3.
Braun, Maximilian, 3.
Brewster, E. T., vii.
British Museum, 94, 98, 114, 158, 411, 417.
Brooke, J. M., 172.
Brooks, Phillips, 19.
Brown-Séquard, 235.
Bunsen, R. W. von, 412.
Burkhardt, Jacques, 15, 19.

Calamocrinus, 272.
Calumet and Hecla Mine; discovery of, 53–55; Mr. Shaw obtains control of, 56; Agassiz sent to, 61; Agassiz's early development of, 62–85; later development of, 85–89; 115, 129, 224–25; fires in, 225–26; 238, 402; underground temperatures in, 402–03; tailings in Torch Lake, 405.
Cambridge, 14; early life at, 15–18.
Capellini, Giovanni, 101.
Caroline Ids., 372; formation, 377.
Carpenter, W. B., 93, 167.
Cary, Thomas, 119.
"Castle Hill," Newport; first mention of, 151.
Challenger, the; A. A. guest of, at Halifax, 121; 167, 173, 174, 176, 181, 247, 263, 351.
Chamberlain, F. M., 420, 426.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Chamisso, A. von; theory of coral reefs, 274.
Chanaral, mines of, 136–37.
Charnay, Désiré, 196, 197, 198, 199.
Chichen, ruins of, 196, 197–200.
Child, F. J., 16.
Chile and Peru, 131–41.
Christinat, M., 15.
Chun, Carl, 263, 264, 266, 351.
Clark, Elizabeth H., 221, 314, 370, 424.
Clark, H. L., 409.
Cleveland, Grover, 219, 312.
Clyde, the tug, 306–07.
Cocks, R., 325.
Columbus; landing of, 290; 293.
"Conspiracy of Silence," 227.
Cook Ids., 363.
Cooke, J. P., 20, 152, 235.
Copacabana, Virgin of, 145.
Coral Reefs, 273–74; Chamisso's theory, 274; Darwin's theory, 275–76; confirmation by Dana, 276; not supported by later investigations, 277–80; Florida reefs, 277–78; Agassiz's views, 279; growth of reef on talus, 279; Tortugas, 280, 281; Florida reefs, 282; Darwin to Agassiz, 282–83; deposit of pelagic shells, 283–84; Agassiz to Darwin, 284–86; Hawaiian Islands, 286–87; Hogsty Reef, 292, 305; of Cuba, 296–97; Bahamas, 297–98; Bermudas, 302–04; Florida reef, 306–09; Tortugas, 307; Great Barrier Reef, Jukes on, 310–11, Agassiz's views, 319–21; Wailangilala bore, 330–31, 333, 335; Hawaii, 335–36; Fijis, 336–42; Funafuti bore, 330, 333, 342–44; Paumotus, 373–76; Pinaki Id., 376; Society Ids., 376–77; Tonga, 377; Caroline Ids., 377; Ellice, Gilbert, and Marshall Ids., 377–78; effect of trade winds, 378; Wilkes's bench mark, 378; Maldives, 389–92; popular book, 395–96; Royal Society lecture, 408–09; 431–32.
Corwin, the, 91, 166.
Croyden, the, 311.
Cuba, elevated limestones of, 296–97.
Curtis, G. C.; model of Funafuti, 343; model of Bora Bora, 377.

Dall, W. H., 341.
Dana, J. D., 276, 280, 322, 324, 329, 333, 335, 336, 358, 362, 375.
Darwin, Charles, 5; "Origin of Species," 47; 48, 49, 50, 51, 97, 98, 113, 118, 119, 120, 123, 136, 141, 227, 228, 255; theory of coral reefs, 275–76; 277, 279, 280, 281; on coral reefs, 282–83; 284, 286, 298, 310, 319, 324, 329, 333, 346, 358, 362, 383, 394, 395, 431.
David, T. W. E., 330, 341, 342, 368.
Davis, Theo., 435.
Derbès, Alph., 45.
Desert of Pacific, 425, 426, 427, 430, 434.
Dolomites, 306.
Dolphin Bank, 378.

Easter Id., 427–30.
Echini, 45–46; first work on "Revision," 47; Agassiz goes abroad to study, 97, 99, 103; printed photographs of, 104; 107; work on "Revision," 114; "Revision of," 121; publication of the "Revision," 122; of Challenger Ex., 158, 159, 160, 161; 162, 167, 182, 193; of Blake Exps., 193; Albatross, 346, 380, 408; "Hawaiian and Other Pacific Echini," 409; Colobocentrotus, 409; Echinonëus and Micropetalon, 409; Panamic Echini, 411.
Echinoderms, embryology of, 45–46, 156.
Eclipse Expedition of Pensacola, 234.
Egerton, Sir Philip, 98.
Egypt, 221, 435–36, 444.
Ehlers, Ernst, 107, 205, 217, 380, 407.
Elevated limestones; of Cuba, 296–97; of Florida, 307–08; slight elevation of Great Barrier Reef, 321; Fiji, 340–42.
Eliot, C. W., 22, 61, 241.
Ellice Ids., 367–69; formation, 377–78.
Embryology; of Echinoderms, 45–46, 156; of jelly-fish, 116, 273; and early development of fishes, 156, 208, 219, 242, 273; Prix Serres for work on, 398.
Emerton, J. H., 289.
Enniskillen, Lord, 98.
Evolution, 5, 48–52, 116, 119, 122–23, 140, 162–64, 434–35.

Failly, P. L. C., de, 111.
Fakarava, 359–61, 375.
Fauntleroy, the, 25.
Felton, C. C., 16.
Fiji, 324–35; formation, 336–43; 366–67, 374, 376.
Florida Reefs, 277–78, 281–82, 284–86, 306–09.
Flounders; early development of, 156; protective mimicry, 156–57.
Flower, Sir W. H., 218.
Forbes, Edward, 113, 165, 166.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Forbes, Henry O., 277.
Forbes, J. M., 53, 288.
Forel, F. A., 211.
Franco-Prussian War, 110–12.
Franklin, Benjamin, 185.
Freiburg, 9–13, 105.
French Academy of Science, 227, 398; Agassiz elected Foreign Associate, 412.
Fulanga, 338.
Funafuti; Royal Society boring, 330, 333, 342–44; 368–69, 409.

Galapagos Ids., 255–58, 430–31.
Gardiner, J. S., 368, 383, 384, 392, 394.
Garman, S. W., 131, 142, 144, 145, 146, 172, 173, 178.
Garrett, L. M., 420, 424.
Georgia, Gulf of, 25.
Gibbs, Wolcott, 130, 146, 152, 332.
Gilbert Ids., 369–70; formation, 377–78.
Girls' school, 23–25.
Godkin, E. L., 220.
Gogebic Iron Range, 192.
Goodale, Geo. L., 235.
Gray, Asa, 16, 228.
Gray, Francis C., 31.
Great Barrier Reef; Jukes's views, 310–11; Agassiz's visit to, 311–19; formation, 319–21.
Griswold, L. S., 308.
Guam, 372–73.

Haeckel, Ernst, 21, 108; Gastræa theory, 116; 126, 158, 351.
Haleakala, 215, 340.
Hardie, George, 80, 83, 84, 85.
Harvard University, 9, 13, 19, 229, 237–42.
Hassler, the, 119, 120, 132, 181, 251, 258.
Hawaiian Ids., 213–16; reefs, 286–87; formation, 335–36.
Hecker, Friedrich, 12.
Hector, Sir James, 43.
Helmholtz, H. L. F. von, 106.
Henshaw, Samuel, vi, 417.
Higginson, H. L., 58, 191, 447.
Higginson, Ida Agassiz, 18, 58, 382, 414.
Hill, R. T., 267, 296, 297, 435.
Hogsty Reef; formation of, 292, 305.
Hooker, Sir Joseph, 98, 228, 412.
Horsford, E. N., 23.
Hôtel des Neuchâtelois, 6.
Hughes, Tom, 98.
Hulbert, E. J., 54–56, 57, 60, 63–65, 66, 67, 83, 84.
Hulbert, John, 67, 84.
Humboldt, Alexander von, 8, 185.
Humboldt Current, 252, 254, 421–22, 425, 430.
Huxley, T. H., 21, 92, 98, 124, 206, 207, 219, 223, 227, 228, 230, 234, 278, 299, 349.
Hyderabad, 208–10.

India, the Durbar at Hyderabad, 208–10.

Jackson, A. C.; discovers Viviparous "Perch," 27.
Jaluit, first mention of, 370.
Japan, 269–71.
Jardin des Plantes, 32, 99, 116, 117, 382, 445.
Jeffreys, Gwyn, 167, 217.
Jukes, J. B.; on Great Barrier Reef, 310–11; 319, 320.

Kambara, 366–67.
Kaup, J. J., 35, 37, 38, 39.
Keeling Atoll, 276, 277.
Kemble, Fanny, 17.
Kent, W. S., 310, 316, 317, 318.
Kimberley, 346, 347.
King, Clarence, 191, 192, 204.
King, Edward, 15.
Koch, Robert, 412.
Kofoid, C. A., 420, 424, 433.
Komo, 339.
Krohn, August, 45.

Laboratory, Newport, 153–56.
Lamarck, Jean, 49.
Lawrence, James, 97.
Leavitt, E. D., 87, 88, 259.
Lefebvre, Jules, 381, 384.
Lepidoptera (first publication of A. A.), 44.
Longfellow, H. W., 16.
Lovén, S., 187.
Lowell, Mrs. Charles, 18.
Lowell, John Amory, 9.
Lowell, J. R., 16.
Lubbock, John, Lord Avebury, 98.
Lyell, Sir Charles, 9, 98.
Lyman, Theodore, 19, 20, 28, 29, 40, 211.

McCandless; borings at Hawaii, 335.
MacDonald, M., 243, 246, 254.
MacNaughton, James, 87, 402.
Makemo, 361.
Maldives, 383–95; formation, 389–92.
Male Id., 386, 390, 393.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Manga Reva, 431; formation of, 431–32.
Manganese nodules, 351, 425; Murray's explanation of, 426–27.
Marcel, Felix, 14.
Marquesas Ids., 352–55.
Marshall Ids., 370–72; formation, 377–78.
Matuku, 339.
Mayer, A. G., 289, 312, 314, 334, 345, 361, 369.
Mayor, Charles, 14.
Mbenga, 325, 334.
Meiggs, Henry, 131.
Menschikov, 371.
Mexico, 203–04; 322–23.
Meyer, Heinrich A., 105.
Milne Edwards, A., 42, 116, 165, 183, 324.
Missionaries, 364, 369, 372.
Monaco, Prince of, 436, 437, 438.
Moore, H. F., 348.
Morgan, Lewis H., 94, 96.
Moseley, H. N., 187, 216, 230.
Moser, J. F., 348.
Motu Iti, 377.
Müller, Fritz, 48, 51, 91, 228.
Müller, Johannes, 45, 46.
Müller, O. F., 46, 165, 170.
Murray, Sir John, 121, 125; memorial address to Agassiz, 158; 204, 210, 227, 228, 235, 266, 272, 277, 278, 279, 282, 283, 285, 298, 300, 301, 317, 323, 324, 328; Funafuti bore, 343; 351, 384, 393, 399, 400, 405; on manganese nodules, 426–27; 446.
Museum of Comparative Zoölogy, 27; early history, 31–32; first Memoirs of, 47; receives $150,000, 93; 103, 127, 128–29, 161, 188, 206, 217–18, 235–37; Agassiz resigns the directorship, 345, 346; Agassiz's contributions to, 399; 414–18.

Nahant, first mention of, 14.
Nansen, Fridtjof, 311.
Neuchâtel, 6–9.
Newcomb, Simon, 412.
Niau, 359, 375.
Nicaragua, Lake, 384.
Niter District, 139–40.
Niue (Savage Island), 363–64.
Norton, Charles E., 115, 196, 203, 238.

O'Brien, Sir George, 324.
Ocean bottom; permanence of, 169; survival of Archaic types on, 186–87; appearance of, 188–89; in desert regions, 426–27.
Oneata, 326.
Owen, Sir Richard, 98.

Pacific, Eastern, 419–33.
Pacific, Tropical, 348–73; atolls of, 373–79.
Packard, A. S., 130.
Palikao, Charles, Comte de, 111.
Panama, Isthmus of, first visit to, 25.
Panamic Report, 186, 243, 247, 256, 266–68, 411, 435.
Papeete, 359, 362.
Patterson, C. P., 169, 180.
Paumotus, 354–62; formation, 374–76.
Peabody Museum, 131, 149, 370, 372, 415.
Peirce, B., 16, 20, 93, 114.
Peirson, Mrs. C. L., 260.
Perrier, E., 187.
Penikese School, 127, 129–31.
Pickering, E. C., 237.
Pigott, W., 385, 394.
Pinaki (Whitsunday), 376.
Porcupine, the, 98, 113, 166.
Pourtalès, L. F., Comte de, 18, 93, 96, 98, 165, 166, 167, 176, 178, 181.
Putnam, F. W., 130.

Rand, the, 192, 346–47.
Rangiroa, 354–58, 375.
Ravenel, Mrs. St. Julien, 18.
Reid Haven, 338.
Richard & Bros., 34.
Rodman, H., 348, 365.
Rongelab, 371.
Ross, Sir John, 166.
Royal Society, 98, 208; Agassiz made foreign member of, 212; Funafuti bore, 342–44, 367; A. A.'s lecture on Coral Reefs, 408.
Russell, H. S., 73.

Sahara Desert, 232.
Schuyler, Philip, 440, 441.
Semper, Karl, 106, 277.
Serpula atolls, 302–04.
Sharks' teeth, 351, 425, 426, 427.
Shaw, J. B., 33.
Shaw, Pauline Agassiz, 17, 29, 414.
Shaw, Quincy A., 29; obtains control of Calumet, 56; 57, 59, 65, 66, 67, 69, 71, 72, 73, 75, 77, 80, 86, 128, 151, 191, 205, 382.
Sherlock, R. L., 341.
Siebold, C. T. E. von, 9, 94.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Sigsbee, C. D., 169, 172, 173, 178; gravitating trap, 184–85.
Sillern, Wm., 161.
Simpkins, John, 73.
Skeats, E. W., 341.
Society Ids., 359, 362–63; formation, 376–77.
Sollas, J. W., 342, 368.
Stevenson, R. L., 360.
Sultan of Maldives, 385, 386, 387, 393, 395.
Suva, first mention of, 324.

Tahaa, 362.
Tahanea, 361.
Tahiti, 359.
Tamaya mines, 134–35.
Tanner, Z. L., 244, 251, 252, 262, 264, 312.
Tetiaroa, 377.
Thayer, Nathaniel, 37.
Thombia, 339, 340.
Thomson, W., 322.
Thomson, Wm., Lord Kelvin, 172, 173.
Thomson, Sir Wyville, 98, 121, 125; invites Agassiz to distribute Challenger collections, 157; 158, 167, 175, 176, 181, 185, 193; death, 204.
Thurston, Sir John, 325.
Titicaca, Lake; Agassiz's exploration of, 142–49.
Tonga, 365–66; formation, 377.
Torell, O. M., 165, 166.
Tornaria, 115.
Tortugas, 280, 281, 307.
Totoya, 326, 339, 340, 367.
Townsend, C. H., 251, 257, 258, 348.
Truk, 372, 377, 431, 432.

Uxmal, 200, 201, 202.

Vaillant, J. B. P., 111.
Victoria Nyanza, 442, 443.
Virchow, Rudolph, 104, 412.
Virginia, the, expedition of, 438–40.
Viviparous "Perch," 27.

Wailangilala; Agassiz's boring at, 330–31, 333; 335, 338.
Wallace, A. R., 98, 417.
Warren, Wm., 17.
Watling's Island; landing of Columbus, 290.
Weismann, Aug., 229.
Wendell, Barrett, vi.
West, P. C. F., 402.
Westergren, Magnus, 244, 250, 251, 253, 346, 381, 409, 421, 423.
Whales' ear-bones, 351, 425, 426, 427.
Wharton, Sir W. J. L., 317, 318, 322.
Whitman, C. O., 208.
Wild Duck, the, 288; voyage of, 289–95.
Wilkes, Chas., 276, 326, 332; bench mark at Point Venus, 378.
Wire rope for dredging, 169, 173–75.
Woodworth, W. McM., 312, 314, 333, 334, 335, 345, 361, 365, 371, 384, 442.
Wyman, Jeffries, 6, 16.

Yangasá, 366.
Yaralla, the, 322.
Yucatan, 194–203.

UNIV. OF MICHIGAN,
OCT 8 1913
Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

The Riverſide Preſs
CAMBRIDGE . MASSACHUSETTS
U . S . A

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

UNIVERSITY OF MICHIGAN
3 9015 01233 3392

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN